Simulation of Baseline Streamflow, Lake and Wetland Water-Surface Elevations in the Swamp and Pickerel Creek Watershed in the Wolf River Watershed, Near the Proposed Crandon Mine, Wisconsin

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LIST OF ACRONYMS

(* indicates term unique to HSPF)

AARE:	Average Absolute Relative Error
*AGWRC:	Active Groundwater Recession Constant
*AGWS:	Active Groundwater Storage
ANNIE:	USGS FORTRAN Program for data summary and display (Flynn et al, 1995)
*ATEMP-DAT:	Air Temperature Data
*BASETP:	Base Flow Evapotranspiration
*BELV:	Base Elevation
*CEPSC:	Interception Storage
CFS:	Cubic feet per second
COE:	U.S. Army Corps of Engineers
*DEEPFR:	Deep Aquifer recharge; Deep Fraction
*DELTH:	Change in Elevation over reach (ft)
Disc:	Discharge
*ELDAT:	Elevation Data
EIR:	Environmental Impact Report prepared by NMC
EIS:	Environmental Impact Statement
EPA:	U.S. Environmental Protection Agency
*FTABLES:	Tables defining volume vs. discharge relation for the reaches
*FTABNO:	FTABLE Number
*GEN-INFO:	General Information
GENSCN:	Generate Scenarios; HSPF Windows interface program
GFLOW:	Groundwater Flow Model being applied to the Crandon Mine
GIS:	Geographic Information System
GLIFWC:	Great Lakes Indian Fish and Wildlife Commission
GPD:	Gallons per day
GPM:	Gallons per minute
*GWDATM:	Datum for Groundwater Elevations
*GWDEFCT:	Groundwater Deficit
*GWEL:	Groundwater Elevation
*GW OUT:	Groundwater Outflow
*GWS:	Groundwater Storage
HSPEXP:	HSPF Expert System
HSPF:	Hydrological Simulation Program - FORTRAN
*HYDR-INIT:	Initial Hydrological Conditions
*HYDR-PARM:	Hydrological Parameters
*IMPLND:	Impervious Land Cover
*INFILT:	Infiltration parameter
*INTFW:	Interflow
IOWDM:	Input and Output for a WDM; program for data reformatting (Lumb et al,1990)
*IRC:	Interflow Recession Constant
*KVARY:	Variable groundwater recession
LAK2:	Lake Package Module within MODFLOW
*LEN:	Reach Length (miles)
*LSUR:	Overland Flow Length
*LZETP:	Lower Zone Evapotranspiration
*LZS:	Lower Zone Storage
*MELEV:	Mean Elevation
METCMP:	Meteorological Comparison / program for data correction and generation (unpublished)
MICIS:	Midwestern Climate Information Center
MIS:	Management Indicator Species
MODFLOW:	Groundwater Model being applied to the Crandon Mine
*MON-INTERCEP:	Monthly Interception storage capacity parameter
MPA:	Mine Permit Application submitted by NMC
NA:	Not Available
NC:	No Change
NMC:	Nicolet Minerals Company
NWS:	National Weather Service
NRCS:	Natural Resources Conservation Service

*OPN:	Sequence block/ list of model operations (land and stream segments) in order of simulation
*PCW:	Pore Cohesion Water
*PERLND:	Pervious Land
*PET:	Potential Evapotranspiration
*PGRAVW:	Pore Gravitational Water
*PGW:	Pore Gravitational Water
*PLS:	Pervious Land Segment
*PWAT-PARM:	Pervious Water Parameter
QAPP:	Quality Assurance Project Plan
*RCHRES:	Reach of a Stream
Rech:	Recharge
SAS:	Soil Absorption System
SCEN01/ SCEN02:	Scenario 1 and Scenario 2
SCS:	Soil Conservation Service
*SLSUR:	Overland Flow Slope
*SNOW-PARM:	Snow Parameters
*SREXP:	Surface Runoff Exponent
*SRRC:	Surface Runoff Recession Constant
SSURGO:	Soil Survey Geographic (USDA NRCS SSURGO Data)
*STCOR:	Stage Correction (ft); depth + STCOR = Stage
SWSTAT:	Surface Water Statistics (USGS Software)
TMA:	Tailings Management Area - tailings disposal area
UCI:	User Control Input
UPGW:	Gravitational Water Porosity in the upper soil layer (= PGW in this model)
USDA:	U.S. Department of Agriculture
USEPA:	United States Environmental Protection Agency
USGS:	United States Geological Survey
*UZS:	Upper Zone Storage
*UZSN:	Upper Zone Storage Nominal
*VOL:	Initial Volume of Water in Reach (acre-ft)
*WDM:	Watershed Data Management files
WDNR:	Wisconsin Department of Natural Resources
WISCLAND:	Wisconsin Initiative for Statewide Cooperation of Landscape Analysis and Data

Simulation of Streamflow, Lake, and Wetland Water-Surface Elevations in the Swamp and Pickerel Creek Watersheds in the Wolf River Watershed, Near the Proposed Crandon Mine, Wisconsin

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Abstract

The Hydrological Simulation Program - FORTRAN (HSPF) model Version 12 was used to simulate surface water conditions in the 36,172-acre Swamp Creek watershed, and the adjoining 9,423-acre Pickerel Creek watershed in northern Wisconsin. Together these watersheds comprise the study area. Initially the goal of this project was to assess potential changes to the surface-water balance due to proposed mine facilities, dewatering, and subsequent water table drawdown. Subsequently, the scope of the project was altered and the report only provides a baseline condition for the two watersheds.

The model was calibrated using streamflow data collected from 1982-1986 at two locations on Swamp Creek (above and below Rice Lake), yielding correlation coefficients of 0.8773 and 0.8308, respectively, and model-fit efficiencies of 0.6803 and 0.5393 for monthly flows (0.7240 and 0.7254 when three outlier values were removed above Rice Lake and four outliers below Rice Lake). The overall water balance was achieved with a - 6.8% error above Rice Lake, and a 2.6% error below Rice Lake when comparing simulated results to observed data. Other statistical goals related to storms, low flows, and high flows were within the error criteria established in the Quality Assurance Project Plan (QAPP) and data quality objectives. Temporal verification used data from 1978 -1981, and spatial verification was provided by simulation of lake water-surface elevations in the adjacent Pickerel Creek watershed. The correlation coefficients for verification above and below Rice Lake were 0.8124 and 0.8222, respectively, and the model-fit efficiencies were 0.5218 and 0.5266 for monthly flows above and below Rice Lake, respectively (0.5539 and 0.6476 when three outlier values were removed). All of the other error criteria remained well within the targets except the total storm volume, which missed by -4.5%. A simulation baseline representing natural conditions was established using a 41-year continuous time-series of meteorological data (1955 - 1995). Using the calibrated parameter set, a baseline of lake water-surface elevations was developed for the Pickerel Creek watershed.

INTRODUCTION

The U.S. Environmental Protection Agency (USEPA) has applied the Hydrological Simulation Program - FORTRAN (HSPF) Version 12, a hydrologic model, to qualitatively and quantitatively evaluate the baseline of the surface water resources of the area near the proposed Crandon, Wisconsin, mine. Due to the purchase of the project area by the Mole Lake Band of the Sokoagon Chippewa and the Forest County Potawatomi Community, the original scope of the project has been narrowed from assessing potential mining impacts on the water budget of the area. The project will now only assess baseline conditions currently present in the project area. The model has been used extensively by the U. S. Geological Survey (USGS) and consulting engineering firms to simulate and evaluate watershed management plans, storm-water impacts, and solute transport (Duncker et al., 1995; Duncker and Melching, 1998; Jarrett et al., 1998; Zarriello and Ries, 2000).

This document is the final work product of an Interagency Agreement between the USEPA and the USGS in Wisconsin and Illinois. Through a subcontract, the USGS has acquired the services of AQUA TERRA Consultants (which maintains the HSPF model for the USGS and USEPA), to develop and evaluate this HSPF model to establish a hydrological baseline for the area.

This project was started because the processes of runoff, snowmelt, evapotranspiration, interception, and interflow, and the changes in these processes due to construction and operation of the mine are not simulated in groundwater flow models being developed by the U.S. Army Corps of Engineers (COE), Wisconsin Department of Natural Resources (WDNR), and others. Simulation of these processes is critical to a more complete understanding of the effects of mining on the environment and to address unique issues, such as maintaining the viability of wild rice and the wildlife, stream, and wetland habitat which is culturally significant to the four Native American Tribes and other residents located in proximity to the site. Given the potential impacts of the mine on such a geologically and hydrologically complex area, the land-surface portion of the hydrologic cycle is simulated with HSPF with an emphasis on the surface waters, the water budget, and fluctuations of the water budget. Wild rice is culturally significant to the Mole Lake Band of the Sokaogon Chippewa, and the reservation location was chosen due to the presence of the wild rice at Rice Lake and Mole Lake. HSPF can simulate soil erosion, sediment transport, and pollutant transport within a watershed, but this option was not applied in this study because of the lack of sediment and pollutant load data in the Swamp and Pickerel Creek watersheds needed to calibrate any modeling.

Residents of the area potentially affected by the mine include four tribes of Native Americans within a few miles of the proposed mine: the Sokaogon Chippewa Community Mole Lake Band, the Forest County Potawatomi Community, the Menominee Indian Tribe of Wisconsin, and the Stockbridge-Munsee Band of the Mohican Indians. The Sokaogon Chippewa Community Mole Lake Band and Forest County Potawatomi live in close proximity to the mine site in the Swamp Creek watershed, which covers the southern and eastern part of the Upper Wolf River and Post Lake Watershed (Figure 1). The Potawatomi lands are also located in the Peshtigo River Watershed.

Acknowledgments

The authors would like to thank the project team leader at the USEPA, Dan Cozza, whose constant guidance and support was instrumental in keeping the project alive. Thanks are given for the peer review and recommendations by Dr. Raymond Whittemore and Dr. Gustavius Williams. Initial modeling runs were performed by USEPA intern Troy Naperala. Thanks also are extended to Dr. Alan Lumb for his review of and suggestion on the model calibration and verification procedure and results. Both quality assurance input and encouragement by Joan Karnauskas are greatly appreciated. Thanks are given to all those who provided field assistance, data, and insight to the complexity and unique qualities of the area, including the Tribes, Great Lakes Indian Fish and Wildlife Commission, and Nicolet Minerals Company (NMC). Thanks to Margaret Thielke who built a great team by pulling together all those from AquaTerra Consultants and the USGS in the early phases of the project, and who saw the utility of surface water modeling.

SITE AND PROJECT DESCRIPTION

Two watersheds located within the Wolf River watershed are examined in this study (Figure 2). The Swamp Creek watershed has an area of 36,172 acres (56.5 mi^2). The Pickerel Creek watershed is adjacent to and south of Swamp Creek and Rice Lake and has an area of 9,423 acres (14.7 mi^2). The total area encompasses 45,595 acres (71.2 mi^2) and will be referred to as the "study area" (Figure 3).

In this report, HSPF only is used to simulate the baseline water levels (in lakes and wetlands) and discharge corresponding to current, natural conditions. The simulated long-term (41 years) time series of runoff for natural conditions are summarized as frequency distributions of lake levels, wetland levels, and discharges. These frequency distributions may then be analyzed during key times in the life cycle of individual indicator species such as reproductive phases, critical developmental phases, or stress times, to try to determine the range of flows and water depths that indicator species must have to survive under natural conditions. The results from this model may be used by biologists for biological impact assessment, as well as by others for formulating mitigation and long-term monitoring plans.

DATA COMPILATION

The hydrologic cycle is a conceptual framework that describes the movement of water within a watershed and between land, water bodies (streams, lakes, and wetlands), and the atmosphere. Data collection defines watershed characteristics (such as soils and land cover) and provides measured inputs (precipitation), estimates of internal fluxes (potential evapotranspiration, groundwater recharge, and others), and measured outputs (runoff) necessary for the calibration of a hydrologic simulation model.

Hydrologic Data

Runoff data were collected at two streamflow-gaging stations in Swamp Creek, located immediately upstream and downstream of Rice Lake. Electronic data loggers provided continuous-recording stage data at an hourly interval. Streamflow records for the watersheds are rated as "good" (within 10 percent error) for most of the full period of record, except for estimated periods (such as winter periods when the stream is ice-covered or periods of missing record), which are rated "poor" (within 15 percent error). Runoff from the 46.3 mi^2 portion of the watershed above Rice Lake (USGS gage #04074538) (Figure 4), which includes part of the proposed mine site, was measured at the USGS gage from August 1977 to September 1983 and from October 1984 to December 1986. Runoff from the 56.7 mi^2 portion of the watershed below Rice Lake (USGS gage #04074548) was measured at the USGS gage from August 1977 to September 1979 and from April 1982 to June 1985. Streamflow was estimated for each gage site for the periods when the gage was not operational utilizing the data at the other gage and a value of 1.43 for the ratio of flow below Rice Lake to the flow above. Therefore, runoff data are available for a period of 9 years and 5 months (August 1977 to December 1986) at these gages.

A comparison of the contributing land areas to these two gaging stations suggests an approximate ratio of 1.22 for the flow below to the flow above Rice Lake. However, regression analysis of the measured flows produced a ratio of 1.43, which suggests that additional areas are contributing to the station below Rice Lake and/or some of the watershed areas above the lake are not contributing. Particle tracking analysis of groundwater data and model results, discussed further in the "Hydrological Relations" section, strongly supported this hypothesis, and led to contributing land area adjustments in the model.

NMC also made discharge measurements on selected days at 14 locations within the Swamp and Pickerel Creek watersheds between November 1993 and March 1995. These measurements were too infrequent to develop stage-discharge ratings and continuous streamflow data, and they were made outside of the calibration and verification periods (discussed below). They typically were made during low-flow periods at several locations within a few days. Thus, these measurements, even though infrequent, were used to check internal fluxes among subsections in the HSPF model simulation to determine if the areal distribution of simulated runoff is reasonable.

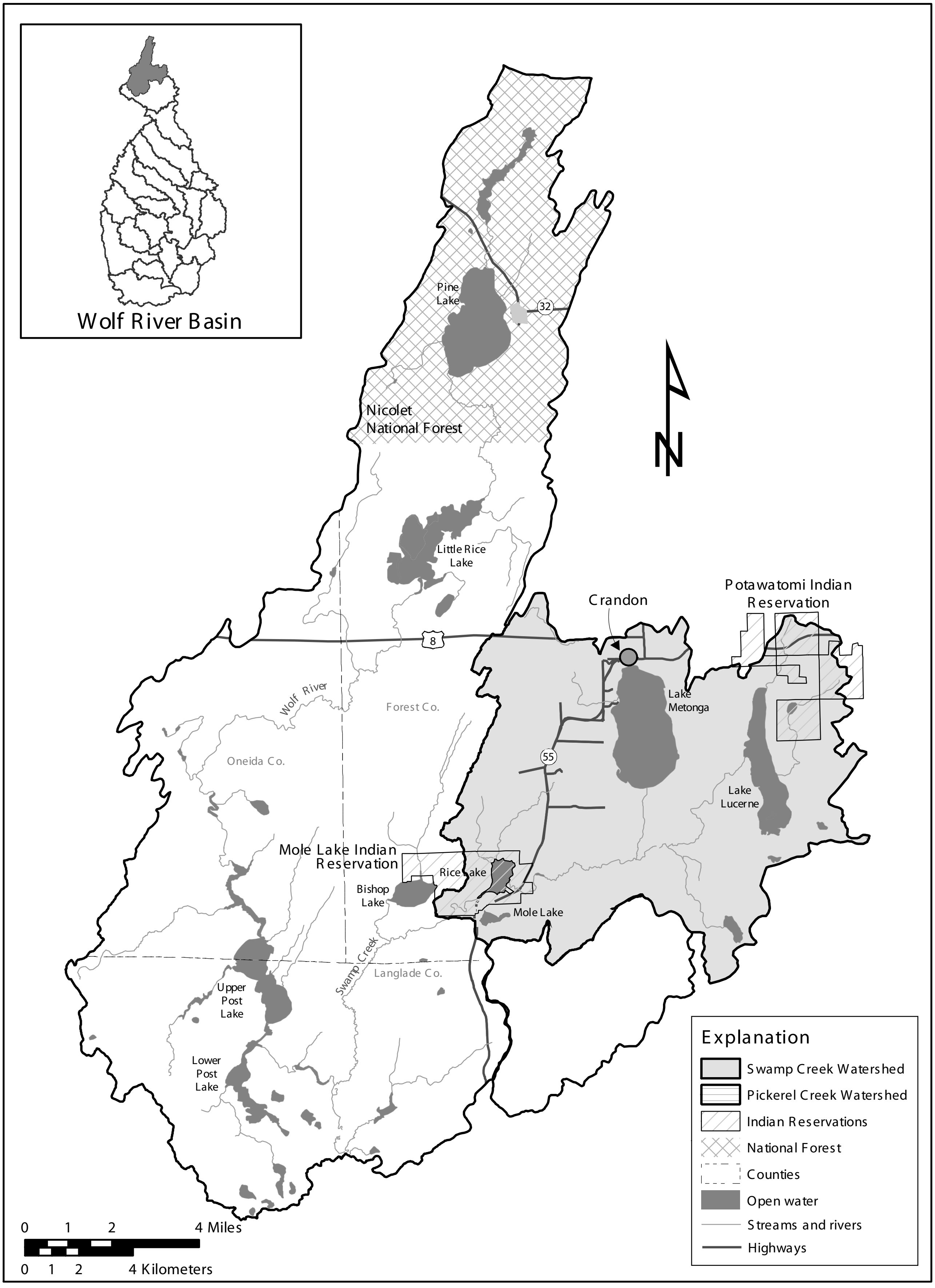


Figure 1. Location of the study area in Upper Wolf River and Post Lake Watersheds.

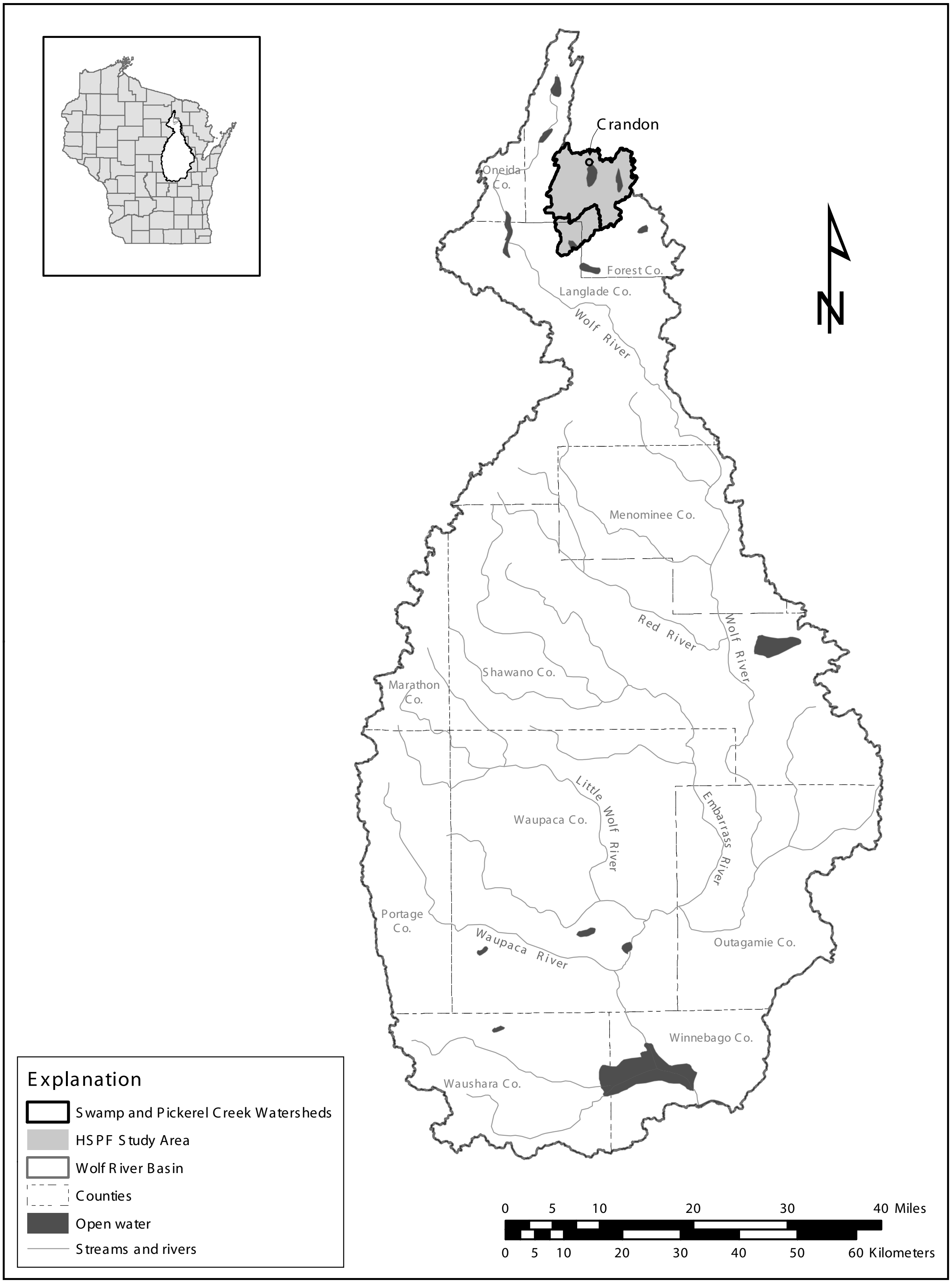


Figure 2. Location of the study area within Wolf River Basin in Forest and Langlade Counties, Wisconsin.

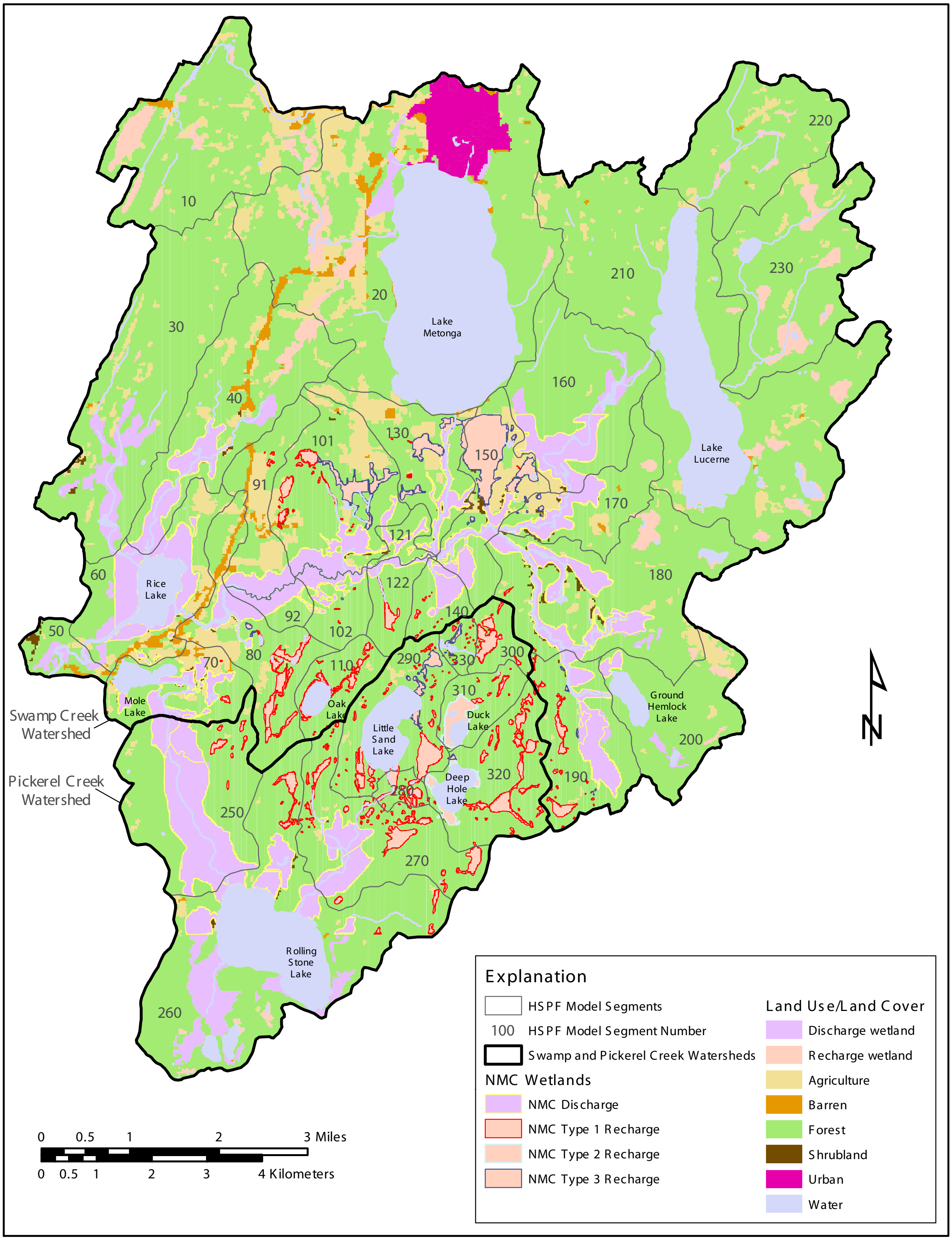


Figure 3. Study area land use/land cover with wetlands and HSPF segments.

Water-level data for 314 observation wells in the vicinity of the proposed Crandon Mine are available on a monthly basis sporadically from 1977 to 1995. Among these, 23 wells are located in wetlands (Figure 5) and can be used to guide the calibration and verification of the simulation of wetland water levels with HSPF. Lake-level data are sporadically available on a monthly basis from 1977 to 1995 for Deep Hole Lake, Duck Lake, Little Sand Lake, Oak Lake, Rolling Stone Lake, Rice Lake, Skunk Lake, Ground Hemlock Lake, and Hoffman Springs. The data are available from the NMC EIR. Figure 6 shows locations of cross-sections measured in the field to help determine stream channel dimensions for estimation of properties of the FTABLES portion of the model, quantifying characteristics of the lakes and streams.

The meteorological data or estimates required for the hydrologic modeling include precipitation, potential evapotranspiration, snow depth, air temperature, dew-point temperature, wind speed, cloud cover, and net solar radiation (Table 1). Meteorological data were thoroughly analyzed for consistency and completeness prior to model simulation. Reliable data were available from 1955 through 1995, so this time interval was chosen for the baseline simulation. Some visual inspection of plots was utilized to detect gross data anomalies. The data were obtained from the National Weather Service, Midwestern Climate Information Center (MICIS) (Kunkel et al., 1990), and other repositories, and re-formatted as Watershed Data Management (WDM) files. All data re-formatting and processing were done using WDM utility software package developed by the USGS. These programs include IOWDM (Lumb et al., 1990) for data re-formatting, ANNIE (Flynn et al., 1995) for data summary and display, and METCMP (USGS, unpublished) for data correction and generation.

Precipitation data are the principal input to the watershed model, providing the driving force for the land-surface portion of the hydrologic cycle, including flow in the soil and snow accumulation and melt. Precipitation data are available at 15 stations (Table 2) as shown on the map in Figure 7. The precipitation data used for the model were developed using the procedure described by COE/Barr, Inc. (1997), in which inverse-distance weighting was used to develop a single long term rainfall record based on the two nearest stations with good quality records. The details of this procedure are as follows: 1) The daily data recorded at Laona and South Pelican Lake were corrected (i.e., missing values were filled) using data from the Summit Lake station. The values for the missing periods were adjusted by factors to account for differences in long-term average rainfall totals at the stations. The adjustment factors were 0.882 for Laona 6SW and 0.930 for South Pelican Lake. 2) The corrected Laona and South Pelican Lake datasets were combined using weighting factors computed from inverse distance factors based on the distance from each station to the location of the proposed mine tailings management area; the weighting factors, shown in Table 3, range from 57% to 84% for Laona 6 SW and 16% to 43% for South Pelican Lake, due to the changing location of the Laona 6 SW station. 3) The resulting daily record was dis-aggregated to a one-hour interval using the hourly pattern at the Three Lakes station, with missing periods in the Three Lakes record filled by data from White Lake and, if necessary, Green Bay Airport.

Evaporation estimates are input to the model in the form of potential evapotranspiration (PET) in units of inches per day. The HSPF model computes actual evapotranspiration from each soil zone based on the input PET time series and soil zone-specific evapotranspiration parameters. The PET estimate set used in the modeling was obtained from the Midwestern Climate Information Center (MICIS). The estimates were computed using the Penman-Monteith method (Monteith, 1965) from meteorologic data collected at Green Bay Airport. These data were used instead of pan evaporation data collected at Minocqua Dam, because they were more representative of the long term average annual PET (Environmental Data Service, 1979) in the vicinity of the mine site, and because the period of record of the data set at Minocqua Dam did not support long term simulations.

In addition to rainfall and potential evapotranspiration, five meteorological data series are needed as input for the model. These data series, which are used to drive the snow accumulation/melt sub-routines of the HSPF model, are air temperature, dewpoint temperature, wind movement, cloud cover, and solar radiation. Each of the data types was derived from the nearest station to the study area that collects that type of data and has a sufficient period of record to satisfy the long-term model simulation requirements. Where necessary, other nearby stations were used to fill missing periods in the selected data series. Also, snow depth data at three locations were used for comparison with simulated snow pack depths. Table 4 lists the primary stations that were used to provide the auxiliary meteorologic data.

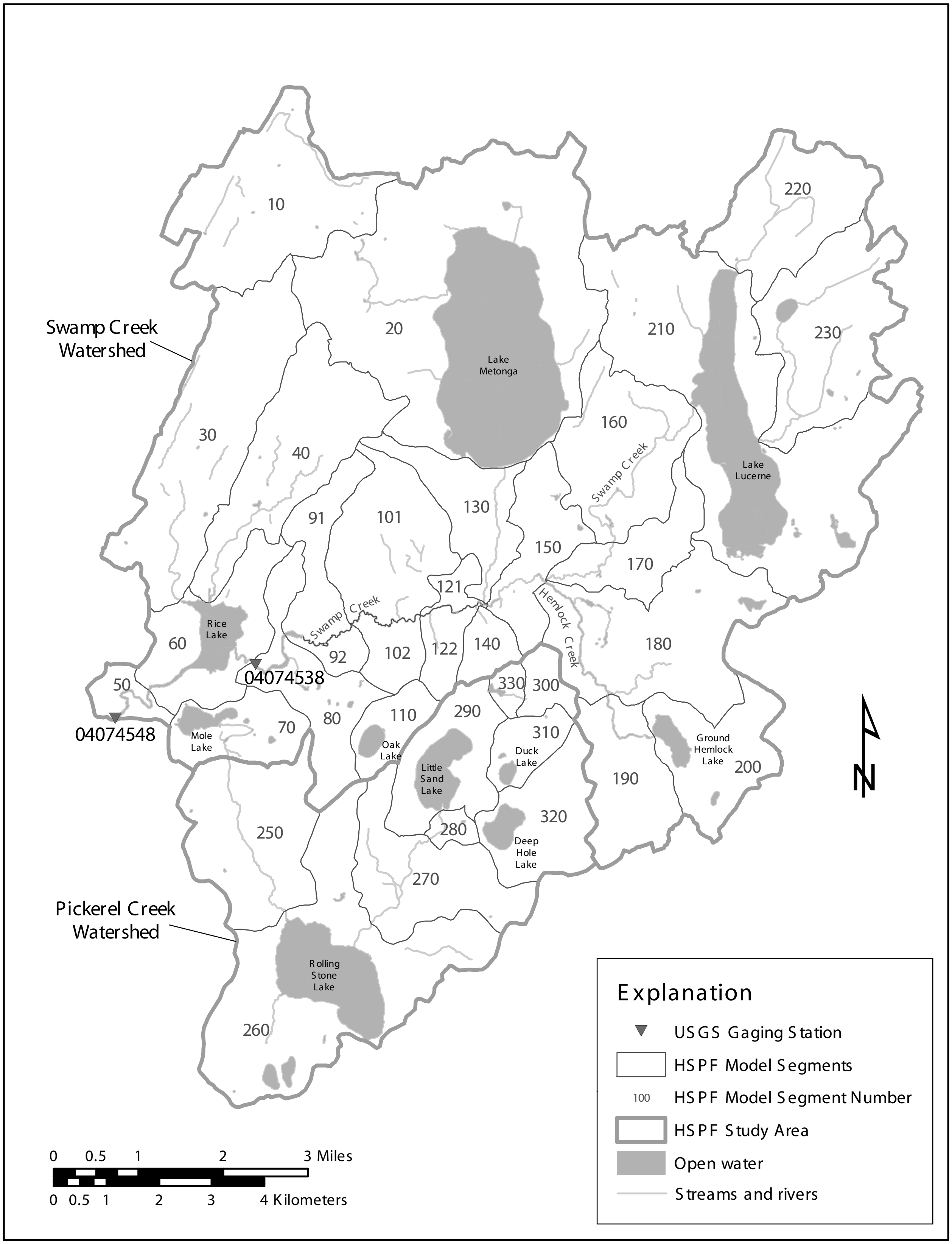


Figure 4. USGS gaging stations and HSPF segmentation.

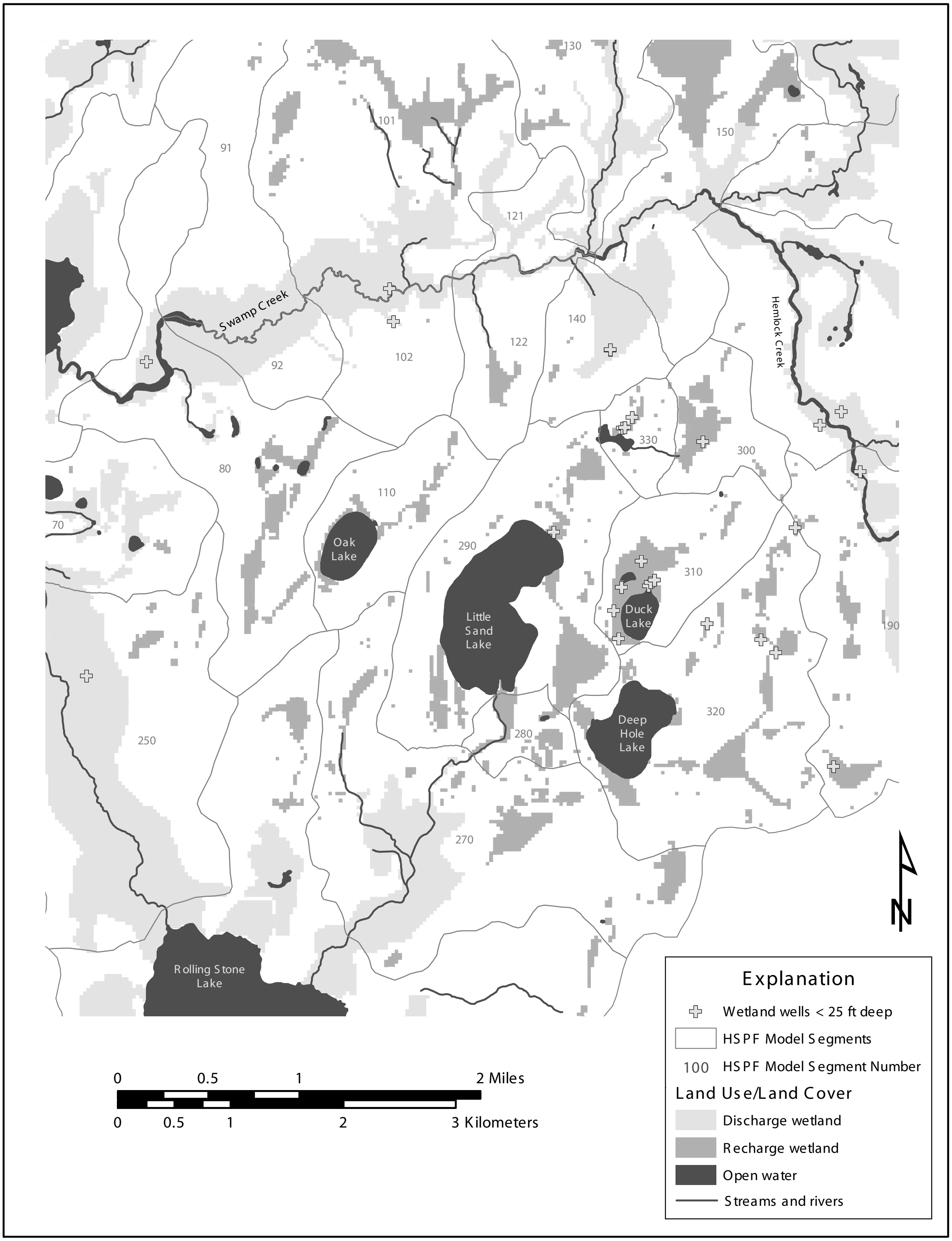


Figure 5. Wetland wells less than 25 feet deep.

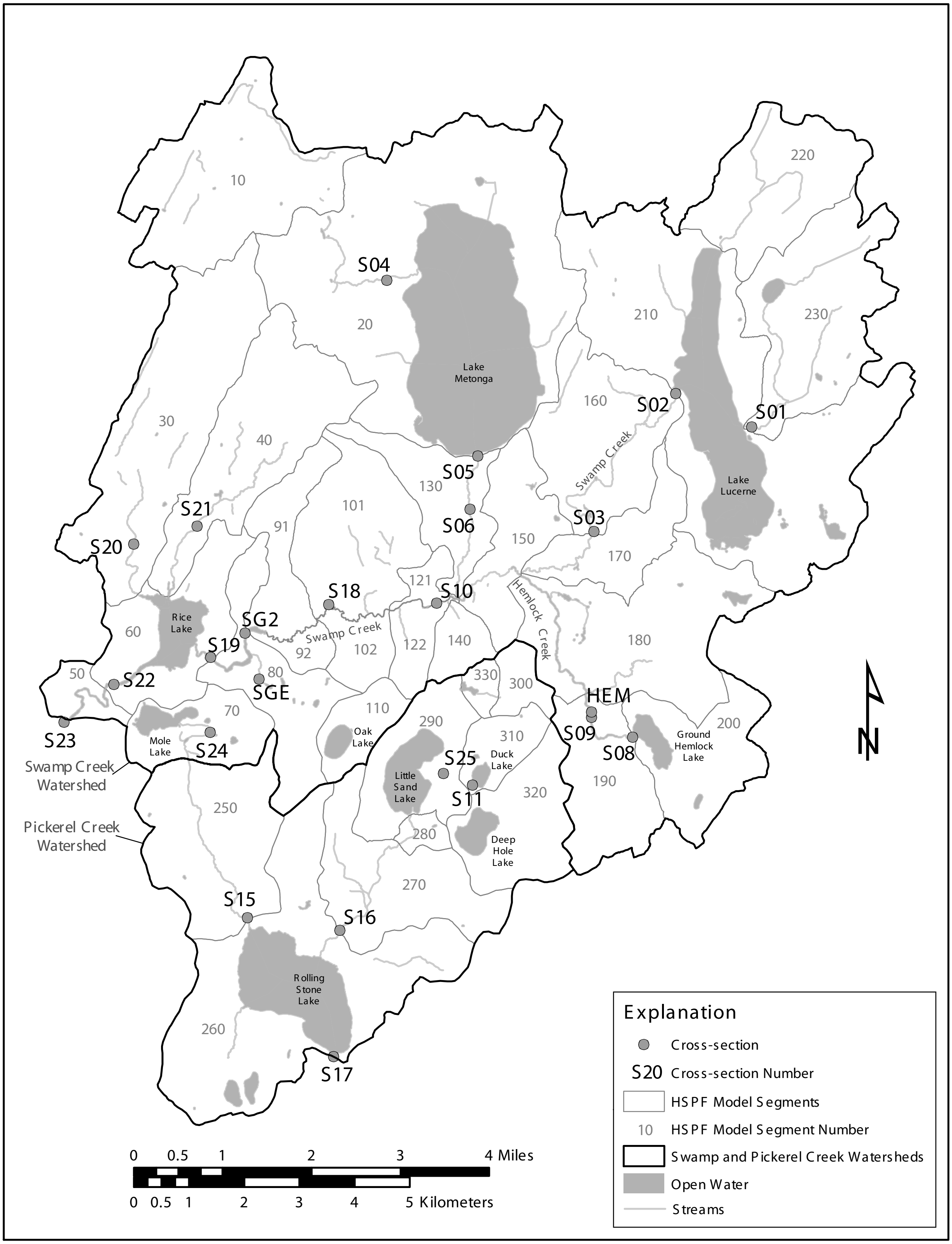


Figure 6. Locations of cross-sections used in HSPF model development.

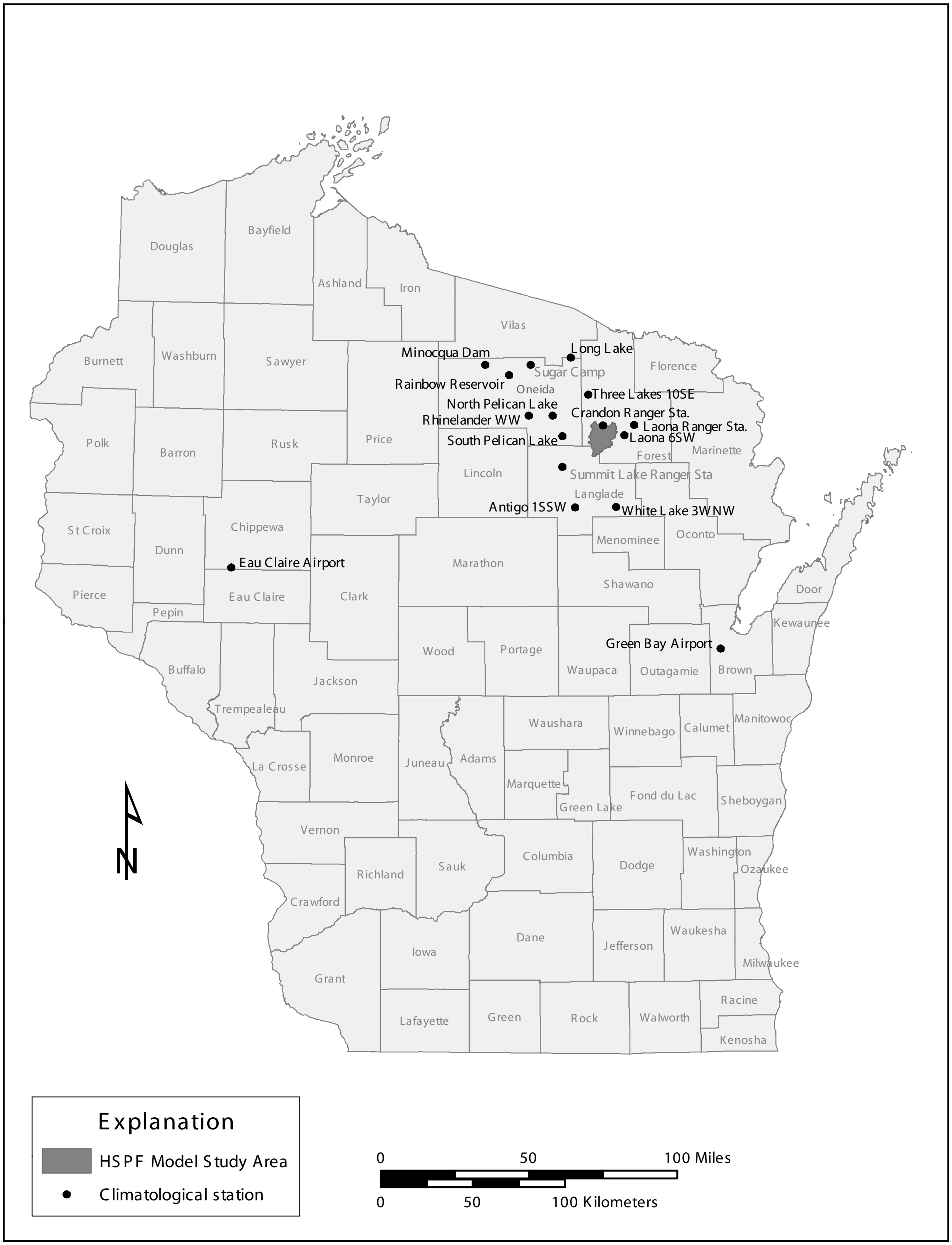


Figure 7. Climatological stations used in this study.

Air temperature data are used to determine whether precipitation falls as rain or snow, and as a component in the snow pack energy balance. The model adjusts air temperature based on lapse rates and the elevation difference between the station and the mean elevation of the land segment. The data series used in this model was based on the station at Laona (6 SW). Daily maximum-minimum data collected at this station were disaggregated to an hourly interval by application of a diurnal curve to the data with the maximum at 4:00 PM and the minimum at 6:00 AM.

Table 1. Data or estimate type, time resolution needed for model, and units

Data Type	Time Resolution for Model	Units
precipitation	1 hour*	inches
potential evapotranspiration	1 day	inches
air temperature	1 hour	deg F
dewpoint temperature	1 day	deg F
wind movement	1 day	miles per hour
cloud cover	1 day	tenths
solar radiation	1 hour	Langleys
streamflow	1 day	cfs
lake levels	1 month	ft
snow depth	1 day	in, ft
groundwater levels	1 month	ft

* All of the rainfall data used directly in the modeling was collected at a 1 day resolution, and was disaggregated to a 1 hour time step by using some nearby stations that were collected at 1 hour intervals.

Table 2. Climatological Stations considered when developing input for the Hydrological Simulation Program-Fortran model of the Swamp and Pickerel Creek watersheds near Crandon, Wisconsin (na, not available)

Station Name	Time Interval	Precipitation Record	Temperature Record
North Pelican Lake	day	1945-1998	1950-1998
South Pelican Lake	day	1945-1997	na
Summit Lake Ranger Station.	day	1948-1998	na
Three Lakes	day, hour	1944-1997	na
White Lake	day, hour	1932-1998	na
Rainbow Reservoir	day	1947-1996	1948-1996
Minocqua Dam	day	1903-1998	1903-1998
Laona 6 SW	day	1927-1998	1948-1998
Antigo1 SSW	day	1896-1998	1896-1998
Crandon Ranger Station	day	1896-1998	1896-1998
Rhinelander	day	1908-1998	1908-1998
Green Bay Airport	day	1896-1998	1896-1998
Eau Claire Airport	day	1949-1998	1949-1998
Sugar Camp	day	1910-1998	1973-1981
Long Lake	day	1908-1998	1908-1996

Table 3. Weighting of Laona 6 SW and South Pelican Lake Precipitation Data used to simulate runoff from the Swamp and Pickerel Creek watersheds near Crandon, Wisconsin

Date	Laona 6 SW	South Pelican
1/48-9/52	57%	43%
9/52-4/53	61%	39%
5/53-5/54	57%	43%
5/54-7/54	65%	35%
7/54-10/69	74%	26%
11/69-1/82	84%	16%
1/82-present	80%	20%

Dewpoint temperature is also used in the determination of whether precipitation falls as rain or snow. Since dewpoint temperature data were not available at any nearby stations, the minimum daily temperature data at Laona 6 SW were substituted for the dewpoint data.

Wind speed, in the form of daily total movement, is used to determine evaporation from the snow pack and atmospheric heat exchange with the snow pack. The nearest wind movement/wind speed station is Eau Claire, WI, and missing periods in this data series were filled using measurements from the Green Bay Airport station. Cloud cover data are used to estimate back radiation to the snow pack from clouds, a component of the snow pack energy balance. The data series used in this model is a combination derived from two stations. The data after 1979 were computed directly from “percent clear sky” data at the Minocqua Dam station. The data prior to 1979 were back-calculated from solar radiation data based on conditions at the Eau Claire Airport station. The daily cloud cover data are expressed as tenths of sky cover, i.e., the values range from 0 to 10, where 0 represents clear sky and 10 represents complete cloud cover.

Solar radiation is used as a component in the radiative heat supplied to the snow pack. It generally is input to the model as hourly values, and often is estimated using solar models and meteorologic parameters, such as cloud cover. The data series used in the Swamp Creek/Pickerel Creek model is a combination derived from two stations. The data starting in 1979 were computed from a simple solar model (Hamon et al., 1954) using clear sky/cloud cover data from the Minocqua Dam station. The data prior to 1979 were obtained from MICIS; they were computed using a more detailed solar model (Petersen et al., 1995), and are based on meteorologic data from Eau Claire Airport.

Table 4. Other meteorological data stations used in developing the input for the Hydrological Simulation Program-Fortran model of the Swamp and Pickerel Creek watersheds near Crandon, Wisconsin.

Data Type	Station Name	Period of Record
Air Temperature	Laona 6 SW *	1948-1997
	Minocqua Dam	1905-1997
	Rainbow Reservoir	1948-1996
	North Pelican Lake	1950-1997
	Antigo	1948-1997
	Long Lake	1948-1996
Dewpoint Temperature	Green Bay Airport	1949-1997
	Laona 6 SW* (estimated from minimum temp)	1948-1996
Cloud Cover	Minocqua Dam *	1978-1995
Solar Radiation	Minocqua Dam * (estimated from cloud cover)	1978-1995
	Eau Claire Airport	1951-1997
Wind Speed	Eau Claire Airport	1949-1997
	Green Bay Airport	1949-1997
Snow Depth	Sugar Camp *	1948-1997
	Long Lake	1948-1995
	Minocqua Dam	1948-1997

* - Primary station for modeling

Land Cover

Land cover affects the hydrologic response of a watershed by influencing infiltration, surface runoff, and water losses from evaporation or transpiration by vegetation. The movement of water through the system, and subsequent erosion and chemical transport, all are significantly affected by the vegetation (*i.e.*, forest, grasses, and crops). The HSPF model segments for the study area consist of approximately 64.5% forest, 10.9% discharge wetland, 10.2% open water, 6.9% agricultural/pasture, 5.1% recharge wetland, 1.1% urban, 1% barren, and 0.4% shrubland (Table 5). The recharge and discharge wetlands, though not the predominant land cover, play an important role in the behavior of the water before it runs into the stream. The forested land cover associated with the rural areas, due to its predominance, is a significant influence on runoff as well.

Five categories of pervious land cover were defined for this study using WISCLAND (Wisconsin Initiative for Statewide Cooperation of Landscape Analysis and Data) and ancillary data layers. They are forest, agriculture/ pasture, urban pervious, discharge wetlands, and recharge wetlands. Variations in the rainfall-runoff process resulting from variations of soil type and slope within these land-cover categories were not considered to be substantial in the Swamp and Pickerel Creek watersheds.

Table 5. Area in acres of WISCLAND land cover category for Hydrological Simulation Program-Fortran (HSPF) segments composing this study area in the Swamp and Pickerel Creek Watersheds near Crandon, Wisconsin

Segment	Urban acres	Ag/pas acres	Forest acres	Water acres	Rechrg acres	Dischrg acres	Barren acres	Shrub acres	Total acres
10	0	281.7	1561.5	16	221.4	0	44	0	2,124.6
20	495.3	686.5	2,424.7	2,019.6	219.6	114.5	158.2	0	6,118.4
30	0	131.1	2,090.9	12.9	4.8	264.5	2.2	7.9	2,514.2
40	0	155.6	1,246.6	0.9	70.8	290.6	57.8	6.7	1,828.9
50	0	16.8	174.7	1.4	0	52.3	13.2	12.4	270.9
60	0	157.2	413.5	209.7	0	418.4	55	4.8	1,258.5
70	0	96	356.6	71.2	3.8	170.9	21.8	9.1	729.4
80	0	143.4	680.5	0.4	89.4	110.8	48.7	3.8	1,076.9
91	0	189.4	337	0	2.7	102.2	36.6	0.3	668.2
92	0	0	90.5	0	0	93	0	0	183.5
101	0	230.7	811.9	3.8	130.1	193.5	9.2	11.5	1,390.7
102	0	0	260.7	1.5	1.4	89.8	0	0	353.3
110	0	4.4	329.7	48.4	40.9	0	0	2.3	425.6
121	0	0	115.5	0	0	45.2	0	2.6	163.3
122	0	0	258.9	0	21	31.6	0	0	311.5
130	0	178.3	472.3	1.1	69.5	110.9	9.8	7.4	849.4
140	0	0.1	191.9	0	4.2	84.7	0	0.1	281
150	0	167.5	295	1	241.2	153	0.8	17.5	875.9
160	0	41	1,147.5	19.4	0	362.3	0	2.2	1,572.4
170	0	72.3	499.2	2.2	17.2	156.6	5.3	10.8	763.6
180	0	76.6	1,571	17.2	79.4	412	0	33.8	2,189.9
190	0	7.2	771.5	2.2	53	219.9	0	1.4	1,055.2
200	0	67	890.1	81.3	22.5	50.6	0	0	1,111.5
210	0	181.1	3,451.4	1,031.6	138.9	0	6.9	0	4,809.9
220	0	67.8	1,269.1	0	41.6	0	2.9	0	1,381.3
230	0	73.4	1,581.5	26.5	187.5	0	0	0	1,869
250	0	20.1	981.2	0	18.1	631.1	0	0	1,650.5
260	0	28.4	2,001.1	714.9	67.6	640.8	3.3	9.9	3,466.1
270	0	9.4	990.5	0	120.4	217.4	0	1.8	1,339.4
280	0	0	88.7	0.7	42	0	0	0.2	131.6
290	0	17.7	637.3	226.8	135.7	0	0	2.6	1,020.2
300	0	1.9	200.2	0	49.5	0	0	1.6	253.2
310	0	0	287.6	26.8	74	0	0	3	391.5
320	0	0	805.7	93.6	139.1	0	0	1.3	1,039.7
330	0	0.4	110.8	6.8	12.3	0	0	1.5	131.8
SUM	495.3	3,102.9	29,396.4	4,638	2,319.6	5,016.3	475.7	156.3	45,595
%Basin	1.1%	6.8%	64.5%	10.2%	5.1%	11.0%	1.0%	0.3%	100.0%

Land cover area for each HSPF segment for the study area (Figure 3) was compiled from the WISCLAND satellite-derived land cover data for Wisconsin and ancillary data layers (Lillesand et al., 1998). Twenty-six WISCLAND Level II land cover categories for the HSPF segments were aggregated into eight Level I categories that included urban, agriculture, grassland, forest, open water, wetland, barren, and shrubland. Boundaries for wetland land cover were updated with the NMC wetland boundaries (from NMC, figure 2.30 in 4.2-3, p. 84. July 1996) updated with information from summer 1999 field visits (personal communication with Dave Siebert, WDNR, 3/22/2000). The town of Crandon accounts for the urban land cover in the model, all of which drains to Lake Metonga and is contained in one HSPF model segment. Inclusion of a separate urban category is warranted for this segment to represent pervious and impervious areas.

Wetlands

Since wetlands significantly impact the overall hydrology and ecology of the study area they warrant additional categorization based on hydrologic relations. Common names for wetlands include bogs, fens, marshes, swamps, etc. The Wisconsin Wetland Inventory Classification Guide (WDNR, 1992) defines a wetland as "an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions" [s.23.32(1), Wis. Stats.]. That is:

Wet soils + water near the surface + potential for wetland plants = wetland

Wetland land cover boundaries were derived from the WISCLAND land cover data updated with the NMC wetland boundaries. WISCLAND wetland boundaries are derived from the Wisconsin Wetland Inventory (WWI) digital linework (WDNR, 1998) whereas NMC wetland boundaries are based on wetland mapping completed in the 1980's and field visits by NMC and WDNR (personal communication with Dave Siebert, WDNR, 3/22/2000). Wetlands were subdivided into recharge or discharge wetlands based on: 1) the NMC wetland map for areas within the NMC study area (the definition of recharge and discharge wetlands used by the NMC is shown visually in the NMC Schematic of Wetland Types, Figure 2.30 in Appendix 4.2-3 of the EIR, July 1996, p. 84, with updates from summer 1999 field visits) and, 2) depth to water table and proximity to groundwater discharge points such as Swamp, Hemlock, and Pickerel Creeks for portions of the HSPF model segments that fall outside the NMC study area. In the latter case, the 1984 water table elevation map did not cover the HSPF model extent and although Forest and Langlade County water table elevation maps are available, their resolution (30 and 50 feet, respectively) is not sufficient to be useful. A water table elevation map, with 5 foot contours, was generated by use of the Analytic Element Model (Memo from Randy Hunt to Chris Carlson, March 2, 1999, "Modifications to the Crandon analytic element model and uncertainty analysis of mine inflow and impacts") to determine the depth to water table, and resulting wetland classification for wetlands that fall outside of NMC's project area.

For the HSPF model, the recharge and discharge wetlands categories were then placed in a pervious land (PERLND) classification in the User Control Input (UCI) portion of the model. After calibration, all of the hydrologic parameter values for both recharge and discharge wetlands were identical. Identical parameter sets were applied for recharge and discharge wetlands because available data were not sufficient to determine differences in hydrologic processes between those wetlands during calibration. The designations are maintained in the UCI file for future modifications of the model as more data become available.

Soils

Soil texture acreages for HSPF land cover segments were calculated by overlaying the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) data for Forest County (Figure 8) with HSPF land cover (Appendix 1). Common soil types in Forest County and their properties are listed in Appendix 2, condensed from Section II-A of the U.S. Department of Agriculture (USDA) (1994) Soil Conservation Service (SCS) Technical Guide. Langlade County soil types and their properties were determined from aerial photos (USDA, 1986) and incorporated into the model, but not overlain with SSURGO data because information for that county has not been entered into SSURGO by the NRCS. In order to simulate water table movement in wetlands with HSPF Version 12, moisture capacity values were obtained from the Technical Guide to estimate the cohesion-water pore space, and effective soil porosity values were obtained from Rawls et al. (1983). Use of these soil properties in HSPF gives a strong physical basis to the simulation of water table movement. These data were used to calculate porosity to quantify the cohesion and gravitational water in the simulation of wetland water levels with the HSPF model. The resulting soil texture was aggregated into the following categories: loam, loamy sand and sandy loam, muck and peat, silt loam, variable (aggregated variable texture and unweathered bedrock), and aggregated/miscellaneous water.

The model can use three types of porosity: (a) porosity in macropores, (b) porosity in the macropores in the upper soil layer, which is equal to (a) in this study and referred to as pore gravitational water (PGW), and (c) porosity in micropores, or pore cohesion water (PCW). The following series of calculations was performed *for each segment* for use in the model:

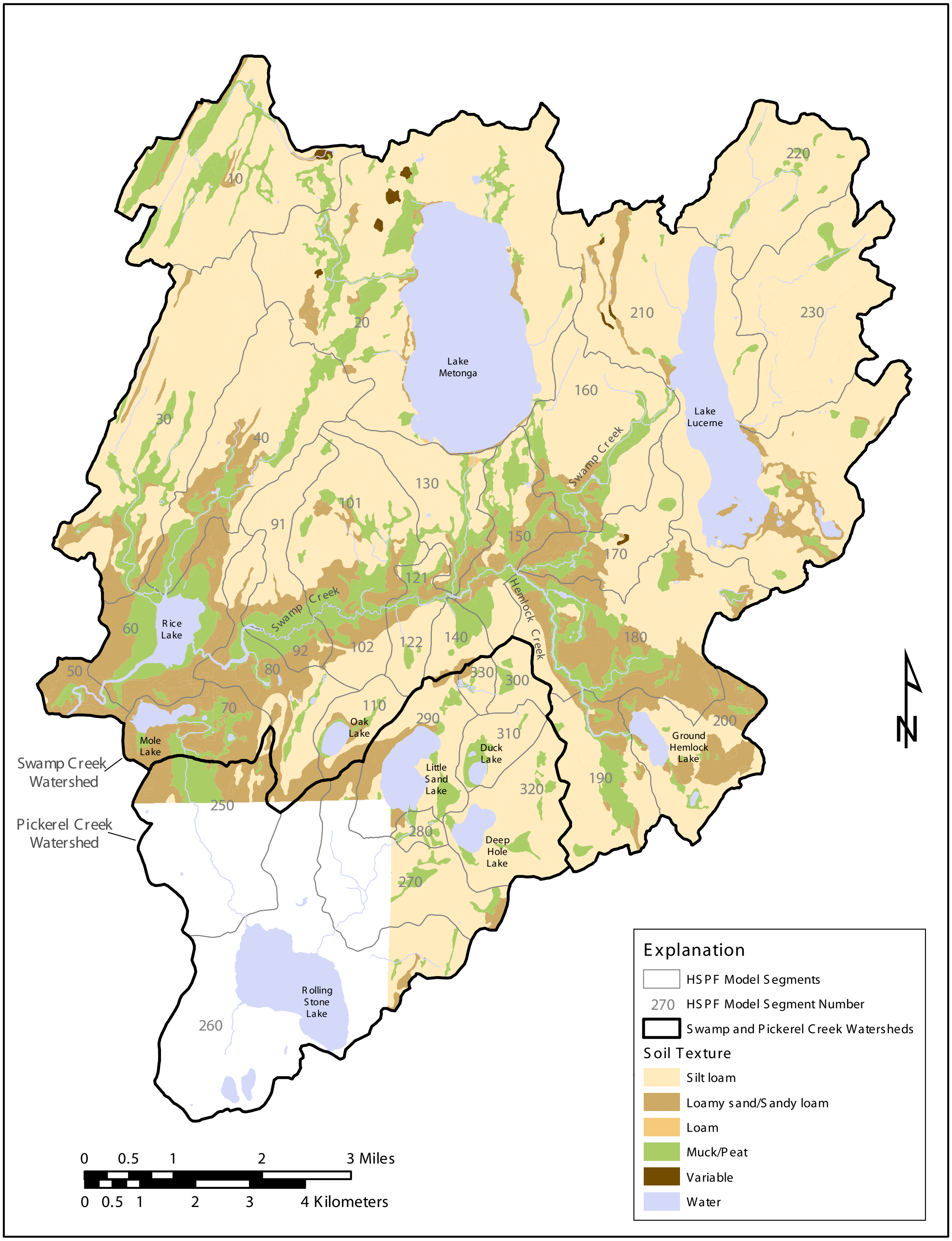


Figure 8. Soil textures for Forest County, Wisconsin (source: USDA NRCS SSURGO Data).

1. total number of acres in a land cover segment was determined
2. the soil texture percentage within the land cover segment was determined
3. the resultant percentage (2) was multiplied by an effective porosity (θ_e) constant for that soil texture
4. the resultant percentage (2) also was multiplied by an available water capacity (PCW) constant for that soil type
5. all the effective porosities from (3) were summed per segment
6. all the PCW values from (4) were summed per segment, and used as PCW in the model
7. then PGW was calculated by the difference of (5) minus (6):

$$PGW = \theta_e - PCW$$

DEVELOPMENT OF WATERSHED MODELS FOR SWAMP AND PICKEREL CREEKS

HSPF is a continuous-simulation model developed from the Stanford Watershed Model. Because it is a continuous-simulation model, it accounts for water stored in the watershed over time, which enables more realistic simulation of antecedent moisture conditions and flood sequences than can be done with event-based models, in which antecedent conditions are estimated. Annual and monthly water balances must be accurately simulated for this premise to be correct. Previous versions of HSPF have been successfully applied to simulate rainfall-runoff, sediment-transport, and pollutant-movement processes in watersheds for a wide variety of water-resources and environmental planning and management activities (Donigian et al., 1995). Version 12 of HSPF (Bicknell et al., 2001) was selected to simulate the rainfall-runoff process in the Swamp and Pickerel Creek watersheds because wetland water levels may also be simulated with this version of HSPF.

HSPF is a numerical model that approximates the terrestrial part of the hydrologic cycle by a series of interconnected water storage zones: an upper zone, a lower zone, and a groundwater zone. The amounts of water in these zones and the flux of water between the zones and to the stream or atmosphere are simulated on a continuous basis for a subarea of a given land cover and precipitation input. The fluxes of water between storage zones, and to the stream or atmosphere, are affected by a large number of model parameters. All the model parameters conceptually have meaning related to their physical attributes or processes in nature, but not all are physically measurable and those must be determined by calibration. The model parameters include threshold values, partition coefficients, and linear-reservoir release coefficients. The flow paths through the upper, lower, and ground water zones and the relations among the storage in the zones, streamflow, and evapotranspiration are shown in the flow chart in Figure 9. The upper zone usually consists of surface vegetation, ground litter, and the upper several inches of soil. Surface runoff and prompt subsurface flow (interflow) are affected by storage in the upper zone. The lower zone is the zone from which deeply rooted vegetation draws water. This water is then lost to the atmosphere through evapotranspiration. The lower zone does not directly discharge to the stream, but strongly affects the amount of water placed in interflow storage, which discharges to the stream. The ground water zone stores the water that supports base flow during periods of no rainfall. Water also can be lost to deep ground water that does not flow to the stream in the simulated area from the groundwater zone.

The simulated wetland levels may be utilized for mitigation, monitoring, and bioassessment of impacts. HSPF Version 12 is newly developed and has not been extensively used, but the model was chosen for its ability to simulate wetland conditions (Hydrocomp, Inc. and Aqua Terra Consultants, 1996).

Version 12 of HSPF accounts for the different saturation conditions and routing of water that occurs in a seasonally saturated wetland. Simulation of the movement of the wetland water level (i.e., water-table elevation) is accomplished by equating lower-zone storage to the pore space in the soil above the minimum channel elevation less the pore space assigned to the upper-zone storage. The porosity in the lower zone is divided into pore space where water is bound to soil particles by capillary forces (cohesion-water pore space) and pore space where water drains downward because of gravitational forces (gravity-water pore space) as shown in Figure 10. The upper-zone storage is composed of the gravity-water pore space near the soil surface. As water enters the soil the water table may move up or down depending on the rate at which the pore space is filled by infiltration and drained to the stream as interflow and groundwater flow. Version 11 of

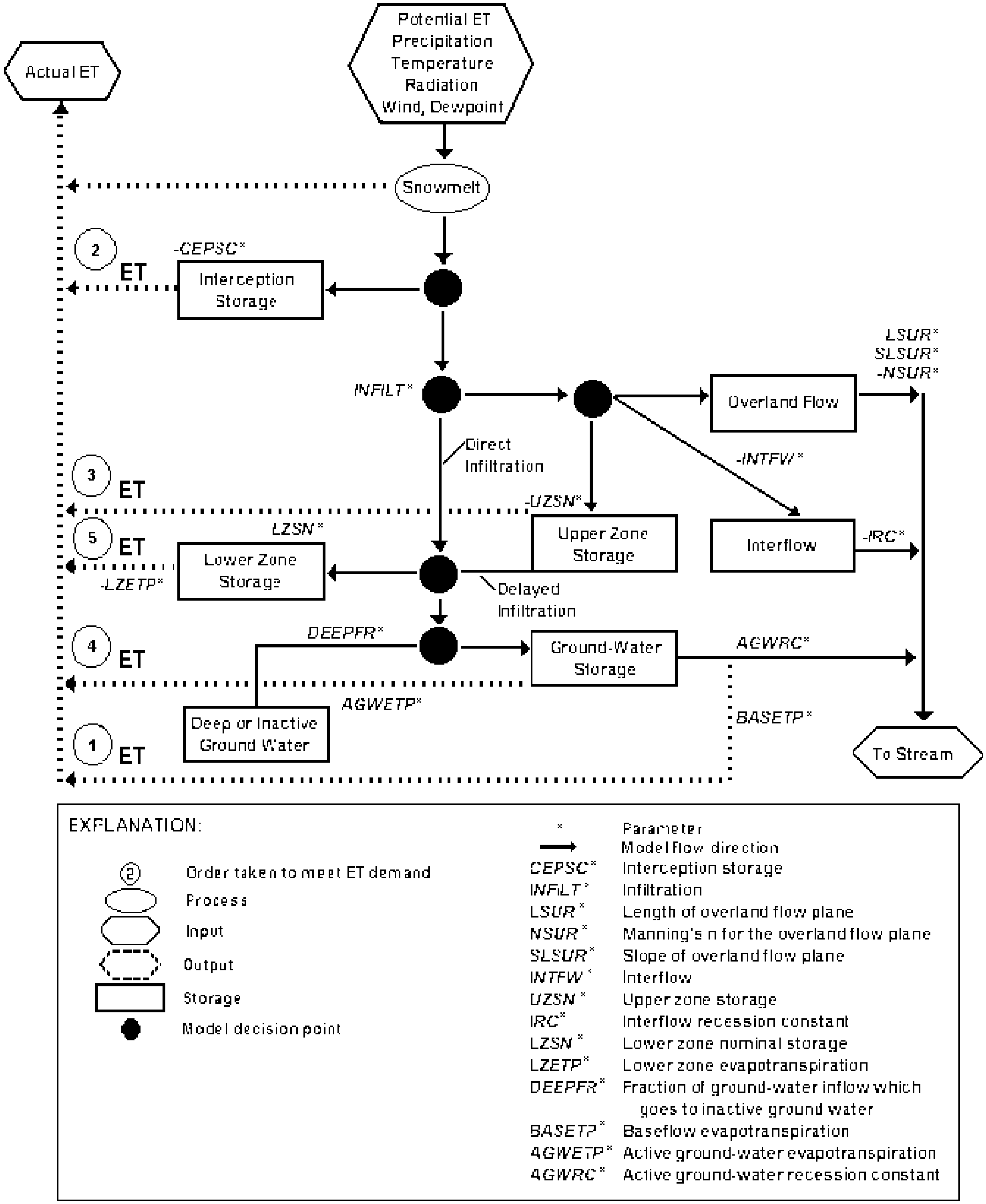


Figure 9
Schematic diagram of the Hydrological Simulation Program - FORTRAN model.

HSPF (Bicknell et al., 1997) limited the water in the saturated upper and lower zones to the original ambient ground-surface elevation as a maximum simulated water elevation. Version 12 removes this limitation and allows the water to be simulated above the land surface and literally "pond" as it would in nature where wetlands are found (see "Wetlands" section). The routing of surface runoff from the wetland may be simulated in three ways: 1) as a function of the land-surface slope (as applied in HSPF for surface runoff where water-table movement is not simulated), 2) using a power function, or 3) using a table where outflow is a function of the depth of ponding. The FTABLE approach was applied in this study because it was the only approach that allowed reasonable ponding to result in wetlands in the study area.

In the Swamp and Pickerel Creek watersheds, runoff from the majority of the overland flow areas passes through wetlands before entering the stream system. Thus, utilizing the topographic data available for the watersheds, runoff from the other pervious land covers (PERLNDs) was input to wetlands in each segment of the watershed as appropriate. For example, if 60 percent of the forest in a segment drained to wetlands before reaching the stream and 40 percent of the forest in a segment drained directly to the stream, the internal routing of runoff from PERLNDs would be set up to simulate this flow pattern. The fluctuating water table was only simulated for wetlands in the Swamp and Pickerel Creek watersheds. All other PERLNDs in these watersheds were simulated with the standard HSPF procedures.

Each watershed studied was subdivided into computational subwatersheds on the basis of physiographic features of the watershed (lakes, tributary streams, etc.), locations where output is desired, and land cover categories. The first two criteria were used to determine the segmentation of the watershed into subwatersheds as shown in Figure 5, based on interpretation of USGS 7.5 minute quadrangles. The subdivision on the basis of land-cover categories was applied to each of the subwatersheds as appropriate for the land cover in that subwatershed. Two broad categories of land cover are utilized in HSPF: pervious land cover (PERLND) and impervious land cover (IMPLND). A wide range of physical attributes can be assigned to a PERLND or IMPLND to represent various land-cover conditions. The pervious category was further subdivided into forest, agriculture/pasture, recharge wetland, and discharge wetland as previously described. In the study area, IMPLND is the urban category found in the town of Crandon, and was used for impervious areas at the plant site. Initial values for model parameters were selected on the basis of previous studies (Donigian and Davis, 1978), watershed characteristics, and preliminary model simulations.

Hydrological Relations

Simulation of runoff from a watershed provides insight into the processes that affect runoff. Though most parameters in HSPF cannot be physically measured, the parameter values should define the general relations among the processes that affect runoff. A conceptualized model of the physical setting for the study area and of the runoff process was developed prior to simulation to guide the calibration procedure. The conceptualization is important in guiding the calibration process because the number of parameters in HSPF permits similar results with different parameter sets. Thus, the model-parameter values and the User Control Input files (Appendix 3) developed in this study reflect the conceptualization of the watersheds and the hydrologic processes that affect runoff. Note that two significantly different conceptual models and two significantly different sets of parameters can both achieve good model-fit efficiency and correlation coefficients and other criteria when comparing simulated and observed data. Thus, a strong conceptual model is very important in modifying the parameters.

The conceptualized model for the two watersheds is based on an analysis of the physical setting in each watershed. The WISCLAND Land Cover database combined with the NMC wetlands layer allowed the model input to represent the physical setting in each watershed quantitatively. The eight Land Cover categories (urban, ag/pasture, forest, water, recharge wetland, discharge wetland, barren, and shrubland) were then recategorized for use in the model to five pervious land covers. They are forest, ag/pasture, urban pervious, discharge wetlands, and recharge wetlands. Variations in the rainfall-runoff process resulting from variations of soil type and slope within these land-cover categories were not considered to be substantial in the Swamp and Pickerel Creek watersheds.

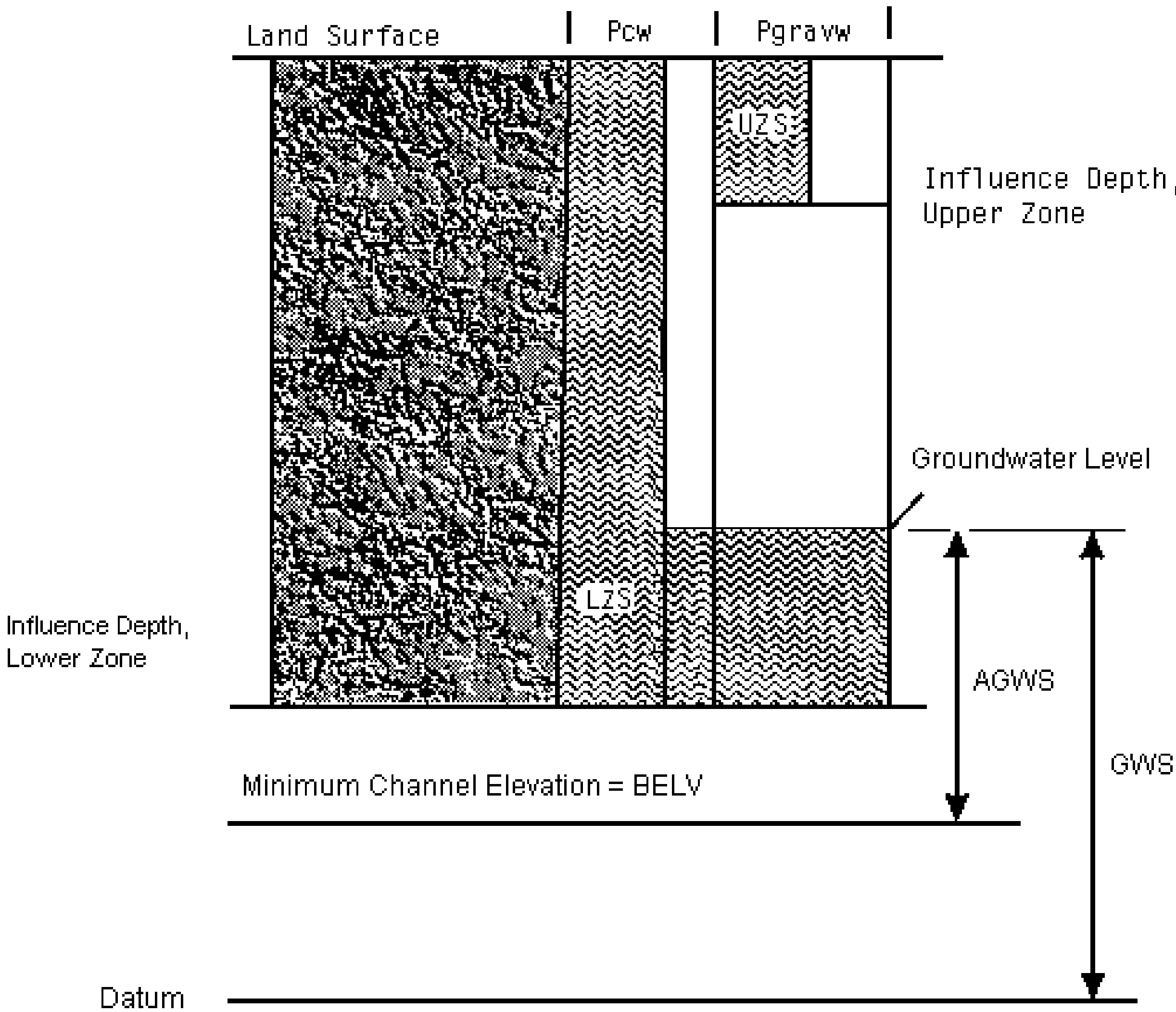


Figure 10
Sketch of soil Moisture in the Unsaturated Zone
as simulated with Version 12 of HSPF

Agricultural and pasture land within the two watersheds was differentiated from other pervious land covers by seasonal variations in the interception storage capacity parameter (MON-INTERCEP) to reflect the different stages of vegetative growth of crops. Forested land was represented in a similar manner. Different seasonal variations in the foliage of deciduous trees was simulated by monthly variation in interception storage capacity.

The conceptualized model for the two watersheds also recognized the importance of the high water table, groundwater and surface water interaction, groundwater contribution to surface water, and the influence of discharge wetlands and the low gradient in the areas adjacent to the streams. As previously described, the parameter sets are the same for both types of wetland, and both receive water from adjacent areas. GIS-based data are the only differences between the two types of wetlands. The low-flow characteristics of the watershed were simulated using the model parameters that controlled the groundwater flow regime, such as the fraction of inflow to the groundwater that recharges deep aquifers (DEEPFR), and the active groundwater recession constant (AGWRC). The base flow evapotranspiration (BASETP) in the model was 0.00. Frozen ground and snowmelt runoff also greatly influence runoff in the spring.

The values for the DEEPFR parameter, which controls the amount of recharge to deep aquifers that do not affect streamflow in the basin being simulated, were selected based on discussions with groundwater modelers at a meeting in Rhinelander, Wisconsin, in December 1998. Based on field evidence, low conductivity of the bedrock, and the results of particle tracking studies, it has been demonstrated that only small amounts of water are taken out of the basin through the deep aquifer.

The surface water and groundwater watersheds, determined by backward particle tracking, for both Swamp Creek and Pickerel Creek are shown in Figure 11. In this revision of the model, adjustments were made to add or remove contributions to the baseflow from areas based on the groundwatershed boundaries as shown in Figure 11. These changes were suggested by modelers who reviewed the original report and felt that the watershed behavior was influenced, to a significant degree, by a groundwatershed that has a different geographical extent than the corresponding surface watershed. The basis for their suggestions was visual observation, supported by the limited number of flow measurements by NMC, that flow in Ground Hemlock Creek was higher than that on Swamp Creek at the confluence of these two creeks. By decreasing the Swamp Creek upstream drainage according to Figure 11, a better balance of Swamp and Ground Hemlock Creek discharges could be obtained in the HSPF simulations. The changes necessary to implement the groundwatershed boundaries were made to the UCI files. These changes included adding or removing areas of groundwatershed from the stream segments and differential routing of surface runoff/interflow compared to groundwater runoff.

As can be seen in Figure 11, particle tracking determined that the groundwater watershed boundary extended quite far to the west of the surface watershed boundary. This effect was supported by comparing the flow at the gage below Rice Lake (measuring the flow of a 32,740-acre watershed) with that through the gage above Rice Lake (26,374-acre watershed); the amount of flow was significantly larger below Rice Lake than the additional surface drainage area alone could account for. The model was adjusted by adding additional groundwater area that was believed to be influencing flow at the gage below Rice Lake (increased from 32,740 to 39,296 acres). The significantly improved agreement between simulated and observed flow below Rice Lake after adding the additional 6,556 acres supports this change.

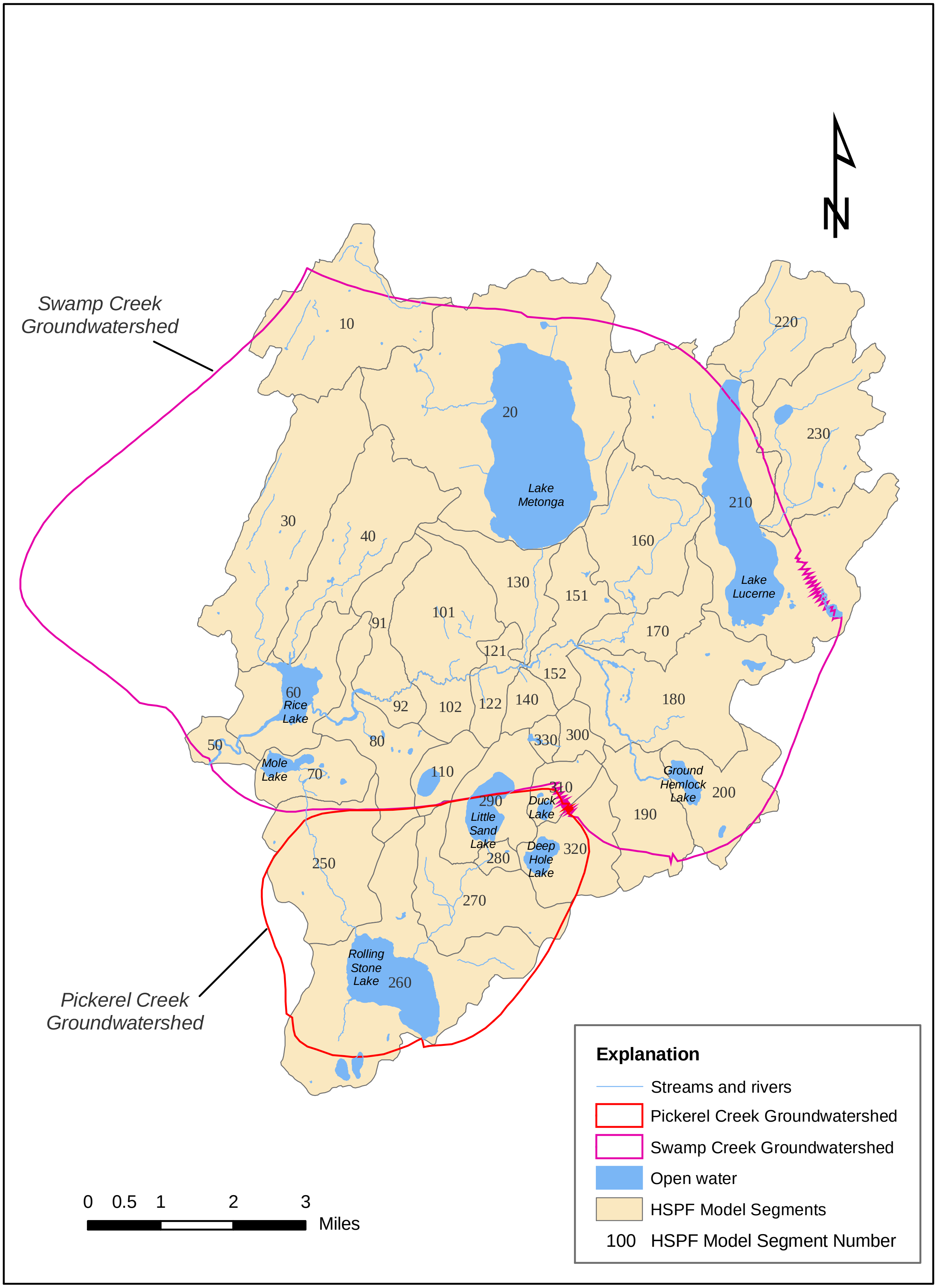


Figure 11. Swamp Creek and Pickerel Creek groundwatershed boundaries from GFLOW model (Swamp Creek - backward tracking from Swamp Creek below Rice Lake at County M; Pickerel Creek - backward tracking from Rolling Stone Lake outlet)

The results of the particle-tracking simulation depicted in Figure 11 also indicated that groundwater flow from the area east of Lake Lucerne does not contribute to the Swamp Creek gages above and below Rice Lake. This result was ignored in the original modeling of the watershed because of uncertainties of the groundwater modelers regarding the groundwater interaction with Lake Lucerne as illustrated in a March 2, 1999, memo from Randy Hunt (USGS) to Chris Carlson (WDNR) where Dr. Hunt states: “Presently there is not enough field information to elucidate Lake Lucerne’s interaction with the groundwater system or the location of the groundwater divide.” Using the surface drainage basin in the original modeling resulted in a flow distribution above the confluence of Swamp Creek and Ground Hemlock Creek (outlet of segment 170) and Ground Hemlock Creek (outlet of segment 180) of 34.7 and 16.2 percent, respectively, of the total flow reaching Rice Lake (outlet of segment 80). These calculations are from the mean flow values in Table 21, page 75 of the original document. This relatively higher flow from Swamp Creek than from Ground Hemlock Creek conflicted with visual field observation of reviewers of the original report who regularly visit the two creeks. Further, the NMC made flow measurements on Ground Hemlock Creek and on Swamp Creek upstream of the confluence with Ground Hemlock Creek and upstream of Rice Lake on three low-flow days in 1994. On these days the flow from Ground Hemlock Creek averaged 16.2 percent and that from Swamp Creek averaged 14.3 percent of the flow into Rice Lake. In total, the NMC made measurements on Ground Hemlock Creek and on Swamp Creek above Rice Lake on 11 days in 1994 and 1995. The flow in Ground Hemlock Creek averaged 25.4 percent of the flow into Rice Lake. For the revised model, the simulated flow in Swamp Creek above the confluence with Ground Hemlock Creek (outlet of segment 170) is 24.4 percent of the flow into Rice Lake, and the simulated flow in Ground Hemlock Creek (outlet of segment 180) is 23.2 percent of the flow into Rice Lake (outlet of segment 80). These calculations are from the mean flow values in Table 18 of this document on page 62 . Thus, the revised model provides a better match of the flow distribution between Swamp Creek and Ground Hemlock Creek than the original model.

The infiltration parameter (INFILT) was initially set to a single value per land cover to simulate relatively uniform soil conditions throughout the study area. This parameter was adjusted for each land cover, then further refined by soil types and hydrographic comparison. PGW and PCW values were calculated individually for each segment to account for the different soil types and their physical impacts on water retention in the upper zone storage. As previously stated in the “Soils” section, soil texture acreages for HSPF land cover segments were calculated by overlaying the NRCS SSURGO data for Forest County with HSPF land cover, and Langlade County by review of aerial photographs. These data were used to calculate porosity for the purpose of quantifying the cohesion and gravitational water in the simulation of wetland water levels with the HSPF model.

The simulation model for the watersheds incorporated a method to account for seasonal variation in runoff resulting from water table fluctuations. Seasonal fluctuation of the water table (high water table in the winter/spring and low water table in the summer) is a common occurrence in northern Wisconsin. Simulation of water-table fluctuation is most affected by two factors, the upper zone nominal storage (parameter UZSN) and lower zone evapotranspiration (parameter LZETP). For both of these parameters, seasonal variations are simulated using values which vary monthly. A high value of UZSN in winter accounts for water frozen and stored in upper zones, a small value in summer accounts for cessation of spring melt and increased evapotranspiration. A larger LZETP value in the summer accounts for higher temperatures and more vegetative/root zone evapotranspiration (Table 6).

Calibration Procedure

The calibration of a surface water model is the primary means of developing the predictive quantitative relation of runoff to rainfall (Troutman, 1985). Complete calibration includes a verification phase in which the parameters optimized during the calibration phase are applied to a separate time period: this is necessary to confirm that the data in calibration years are not anomalous to the overall natural observed trends in a longer time period. The observed data set was divided into a calibration period and a verification period. The calibration period (January 1982 - December 1986) was selected on the basis of a continuous time series of data available in that period. The 60-month period of record available for calibration is sufficiently long to provide an adequate calibration (Donigian et al., 1984, p. 84; Linsley et al., 1982, p. 347). To obtain the most reliable calibration possible, the calibration period was selected to include as much lake level and wetland water level data as possible. The verification period consisted of four years (January 1978 - December 1981). Total, annual, seasonal, and monthly mass balances were determined to evaluate the quality of fit of the calibration.

Table 6. Monthly variable model-parameter values for the best-fit calibration, of the Hydrological Simulation Program - Fortran to Swamp Creek near Crandon, Wisconsin for 60 months (January 1982 - December 1986) calibration.

Parameter	Watershed	J	F	M	A	M	J	J	A	S	O	N	D
UZSN Swamp Creek	forest	1.15	1.10	.75	.50	.50	.25	.05	.10	.25	.50	1.25	1.20
	ag/ pasture	.80	.80	.85	.85	.90	.10	.10	.15	.30	.60	.90	.90
LZETP Swamp Creek	forest	.30	.30	.35	.40	.42	.43	.43	.45	.40	.35	.30	.30
	ag/ pasture, urban, re/disch wetland	.20	.25	.30	.30	.35	.35	.35	.35	.30	.30	.25	.15
MON-INTERCP Swamp Creek	forest	.02	.02	.05	.07	.09	.10	.10	.10	.08	.08	.06	.02
	ag/ pasture, urban, re/disch wetland	.01	.01	.02	.02	.02	.02	.08	.08	.06	.03	.01	.01

Model calibration was achieved in a stepwise manner by first obtaining acceptable annual and monthly mass balances, and then adjusting parameters to obtain estimates of storm-runoff and runoff-duration curves of daily runoff. Calibration is facilitated by the hierarchical structure in HSPF in which the annual balance is most affected by one set of parameters, the monthly balances by another set, and storm runoff by a third set (Donigian et al., 1984). For example, the annual mass balance is primarily affected by varying lower zone evapotranspiration (LZETP), the fraction of percolation going to the deep aquifer (DEEPFR), the lower zone nominal storage (LZSN), and infiltration (INFILT) parameters, whereas seasonal mass balances are affected by varying upper zone nominal storage (UZSN), baseflow evapotranspiration (BASETP), variable groundwater recession (KVARY), and interception storage (CEPSC). Storm runoff is affected by varying INFILT, interflow (INTFW), and the interflow recession constant (IRC).

Many commonly used rainfall-runoff models have built-in calibration routines that estimate the best values of the model parameters as the parameter values that result in a minimization of an objective measure of the agreement between the simulated and observed runoff. The objective measures commonly used include the sum of the squared differences, the sum of absolute differences, and the weighted sum of squared differences (for example, more weight is given to matching high flows). An automatic calibration routine was developed for the Stanford Watershed Model (James, 1972), but due to the size of the model-output file and the complexity of the model, calibration could only be performed for 1 year of data at a time and the optimum parameter values for each year in the calibration would be averaged to determine the best overall parameter set. Averaging optimum parameters for several years is not a suitable approach when year-to-year variations in rainfall and runoff are large. Thus, no formal calibration routines have been developed or advocated for HSPF, and HSPF calibration must be accomplished by trial and error.

HSPF calibration is performed in a stepwise manner primarily using data available at stream flow gages and matching the overall water budget, the annual water budgets, the monthly and seasonal water budgets, and finally, considering storm-runoff volumes. In evaluating the monthly and seasonal water budgets and storm-runoff volumes, the relative proportions of high flows and low flows are considered. Several criteria must be utilized to determine if the quality of the fit between the simulated and observed runoff is acceptable. James and Burges (1982) recommend that graphical and statistical means be used to assess the quality of fit because trends and biases can be easily detected on graphs, and statistical measures provide an objective measure of whether one simulation is an improvement over another.

For the study area, model-parameter values reflecting the current, natural conditions were determined by calibration and verification utilizing runoff data from stream gages at Swamp Creek above Rice Lake and Swamp Creek below Rice Lake, as discussed in the “Hydrologic Data” section . Flow from much of the area potentially affected by the proposed mine is measured at the Swamp Creek above Rice Lake stream gage and is representative of the remaining affected area in the Pickerel Creek watershed. The data from the gage below Rice Lake were used to ensure flows and water levels in Rice Lake itself are correctly represented in the model.

Spatial verification was evaluated by applying the HSPF model with parameters determined for the Swamp Creek watershed to the Pickerel Creek watershed, simulating monthly lake levels, and comparing the simulated values to the measured values. No streamflow gaging stations exist in the Pickerel Creek Basin. Very limited lake level and discharge data were obtained from the EIR, the Tribes, USEPA, COE, Great Lakes Indian Fish and Wildlife Commission (GLIFWC), and others.

Calibration Criteria

Because calibration matches the overall water balance, the annual water balances, the monthly water balances, and considers storm-runoff and duration, several criteria must be considered to determine if the quality of the fit between the simulated and observed runoff is acceptable (USEPA, 1998).

For the overall and annual water budgets only the percentage error is considered. Donigian et al. (1984, p. 114) state that for HSPF simulation the annual or monthly fit is "very good" when the error is less than 10 percent, "good" when the error is between 10 and 15 percent, and "fair" when the fit is between 15 and 25 percent. The target for acceptable calibration and verification for this study was simulation of the overall and annual water budgets within 10 percent of the measured values.

Plots of observed and simulated runoff were prepared for the monthly water budget and checked for periods of consistent oversimulation or undersimulation of runoff. The quality of fit for monthly values was examined using three statistics: (1) the correlation coefficient between simulated and observed flows, (2) the coefficient of model-fit efficiency (Nash and Sutcliffe, 1970) between simulated and observed flows, and (3) the number of months for which the percentage error is less than a specified percentage (10 and 25 percent were used in this study). The average relative percentage error in monthly flows over the calibration period was also considered. Relatively small overestimates in months with very low flows may make this statistic a poor indicator of the overall quality of the fit. However, this problem was not substantial for Swamp Creek, and thus the average relative percentage error was considered in the calibration of HSPF to Swamp Creek. The correlation coefficient, C, is calculated as

$$C = \frac{\Sigma\,(Qm_I - Qm) * \sum(Qs_I - Qs)}{[\Sigma\,(Qm_I - Qm)^2\ \Sigma(Qs_I - Qs)^2]^{1/2}} \quad (1)$$

where Qm_I is the measured runoff volume for month I, Qs_I is the simulated runoff volume for month I, Qm is the average measured monthly runoff volume, Qs is the average simulated monthly runoff volume, and I = 1,..., N, where N is the number of months in the calibration or verification period. The coefficient of model-fit efficiency, E, is calculated as

$$E = \frac{\Sigma(Qm_I - Qm)^2 - \Sigma(Qm_I - Qs_I)^2}{\Sigma(Qm_I - Qm)^2} \quad (2)$$

From the definition above it is clear that the coefficient of model-fit efficiency represents the fraction of the variance in the measured monthly flows explained by the model.

James and Burges (1982) suggest that an excellent calibration is obtained if the coefficient of model-fit efficiency exceeds 0.97, and present an example of an HSPF application where both the correlation coefficient and the coefficient of model-fit efficiency for daily flows exceeds 0.98. For the Stanford Watershed Model (a predecessor of HSPF), Crawford and Linsley (1966) reported correlation coefficients for daily flows between 0.94 and 0.98 for seven watersheds ranging in size from 18 to 1,342 mi^2 and with 4 to 8 years of data. Other researchers studying monthly flows have determined best model fits with lower coefficient values. Ligon and Law (1973) applied the Stanford Watershed Model to a 561-acre experimental agricultural watershed in South Carolina and obtained a correlation coefficient and a coefficient of model-fit efficiency for monthly flows of 0.966 and 0.931, respectively, for a 60-month calibration period. Chiew et al.

(1991) applied HSPF to a 56.4 mi^2 agricultural watershed in west Tennessee and obtained a correlation coefficient for monthly flows of 0.8 for a 54-month calibration period. Duncker et al. (1995) applied HSPF to five watersheds in Lake County, Ill., ranging in size between 6.3 and 59.9 mi^2. For a 43-month calibration period, the correlation coefficients for monthly flows ranged between 0.93 and 0.97 and the coefficient of model-fit efficiency for monthly flows ranged between 0.86 and 0.92 for best-fit calibrations, whereas for regional calibrations (in which three of the watersheds were calibrated jointly) and verification (on two watersheds) the correlation coefficient ranged between 0.93 and 0.95 and the coefficient of model-fit efficiency ranged between 0.86 and 0.91. Duncker and Melching (1998) applied HSPF to three watersheds in Du Page County, Ill., ranging in size from 11.1 to 18 mi^2. For a 45-month calibration period, the correlation coefficients for monthly flows ranged between 0.93 and 0.96 and the coefficient of model-fit efficiency for monthly flows ranged between 0.86 and 0.92 for best-fit calibrations, whereas for regional calibrations (joint calibration of all three watersheds) the correlation coefficient ranged between 0.92 and 0.94 and the coefficient of model-fit efficiency ranged between 0.83 and 0.86. Verification for a 39-month period was not so successful. Two of the watersheds had good correlation coefficients (0.88 and 0.93) and coefficients of model-fit efficiency (0.67 and 0.88), but the third watershed had a correlation coefficient of 0.78 and a coefficient of model-fit efficiency of 0.34. Jarrett et al. (1998) applied HSPF to two watersheds in Jefferson County, Ky., ranging in size from 17.2 to 18.9 mi^2. Calibration to one watershed for a 36-month period yielded a correlation coefficient for daily flows of 0.91 and a coefficient of model-fit efficiency for daily flows of 0.82, whereas verification on the other watershed for the same 36-month period yielded a correlation coefficient of 0.88 and a coefficient of model-fit efficiency of 0.77. Finally, Zarriello and Ries (2000) applied HSPF to two watersheds in the same basin in Massachusetts with drainage areas of 44.5 and 125 mi^2. They obtained coefficients of model-fit efficiency between 0.9 and 0.98 for monthly flows and between 0.79 and 0.88 for daily flows over a 5-year calibration period. Donigian (Aqua Terra Consultants, written communication, 1997) indicated that in areas where snowmelt is a major factor and meteorological data are sparse, it may be difficult to obtain the high correlation coefficients and coefficients of model-fit efficiency reported in the previously listed studies. The targets for acceptable calibration and verification of monthly flows were set at a correlation coefficient greater than 0.85 and the coefficient of model-fit efficiency greater than 0.8.

Some targets for calibration and verification were difficult to achieve because:
1) Rain Gages - All precipitation data were measured outside of the Swamp and Pickerel Creek basins. Watersheds for which excellent calibrations have been obtained typically included several rain gages within the watershed (e.g., Jarrett et al., 1998). Because of the small spatial extent of high-intensity convective storms, errors in the rainfall input to models and the runoff estimate from models can be very large, even for small watersheds with several rainfall-gaging stations. For example, Schilling and Fuchs (1986) demonstrated that the magnitude of error in urban-runoff calculations for small watersheds resulting from rainfall, spatial variability may be greater than 100 percent in peak-discharge and runoff-volume estimation. Therefore, matching observed and simulated storm-runoff calculations for all storms is difficult. At best, the specific storm-runoff volumes can be examined to eliminate bias (that is, tendencies to overestimate or underestimate) in the simulated runoff volumes.

2) Data Limitations - The lake and wetland water level data available for calibration and verification are limited temporally. Additionally, the available data on elevations and lake/wetland characterization (e.g., bathymetry
and stage-discharge relations) are less reliable than other data utilized in model development. There were many data gaps in streamflow that had to be interpolated, thus, adding to the potential error.

Given these limitations in simulating storm runoff, the calibration criteria for storm runoff used in the HSPF Expert System (HSPEXP) (Lumb et al., 1994) were applied in this study. These criteria are (1) the error in total flow volumes for selected storms must be less than 20 percent, and (2) the error in total flow volumes for the sum of selected summer storms must be less than 50 percent. The maximum number of storms which may be used for the program is 36, with 25 (3 in summer months) and 19 used for Swamp Creek calibration above and below Rice Lake, respectively. There is a different number of storms because the data below Rice Lake was available in only a 45-month continuous time series rather than 60 months. A total of 19 storms (7 in summer months) were used for Swamp Creek verification. These criteria were refined during calibration (as suggested by Lumb et al. (1994) to 15 percent for all storms and 20 percent for summer storms. In the Quality Assurance Project Plan (QAPP) (USEPA, 1998), it was proposed to compare storm runoff volume frequency for measured and simulated storms. However, because flood frequency was not an important factor to the impact assessment for the proposed mine, the frequency comparison was not done.

The QAPP proposed that calibration and verification of “lake-level” and “wetland-water level” data, as distinct from stream flow data, would be evaluated using correlation coefficients and coefficients of model-fit efficiency. This was not done because available lake and wetland water level data were not sufficient to calculate meaningful values of these statistics. Instead, the quality of calibration and verification of simulated lake levels was determined by the average absolute error between the simulated and observed lake levels. Further, the wetland water-level data represented a fixed point in a large wetland, whereas the water levels simulated with HSPF represented an average over the entire wetland area in a subwatershed. Therefore, the measured and simulated values can only be compared qualitatively. That is, the simulated water table was checked to see if it rose and fell in the appropriate times of the year, and the range in simulated water levels was similar to the range of measured water levels.

The simulation of daily flows was checked by comparing the observed and simulated runoff-duration curves and time series. General agreement between the observed and simulated runoff-duration curves indicates adequate simulation over the range of the simulated flow conditions. Substantial or consistent departures between the observed and simulated runoff-duration curves indicate inadequate calibration. Certain characteristics of the model contribute to differences between the simulated and observed runoff-duration curves. For example, the effects of impervious areas that are not hydraulically connected to the drainage system are not explicitly simulated in the model. These are impervious areas that generate runoff that does not directly enter the stream channel or other parts of the drainage system. Runoff from these areas drains across adjacent pervious areas and may infiltrate before reaching the drainage system.

Three statistics are utilized to evaluate the high-flow/low-flow distribution indicated in a flow-duration curve numerically. These statistics are:

1) The <u>error in the mean low-flow-recession rates</u> based on the computed ratios of daily mean flow today divided by the daily mean flow yesterday for each day for the highest 30 percent of the ratios less than 1 (i.e. during flow recession). The default allowable difference (Lumb et al. 1994) in the mean low-flow-recession rate is $\leq$ 0.03. This value was the target value for this study. The value of $\leq$ 0.02 in the QAPP was a typographical error.

2) The <u>error in the mean of the lowest 50 percent</u> of the daily mean flows. The default allowable error is $\leq$ 10 percent (Lumb et al., 1994).

3) The <u>error in the mean of the highest 10 percent</u> of the daily mean flows. The default allowable error is $\leq$ 15 percent (Lumb et al., 1994)

Channel routing of flows is an integral part of this study. HSPF Version 12, which simulates wetland saturation and routing through wetlands, is a new enhancement of HSPF. Simulated runoff is not delivered to the stream instantaneously, but is routed through the wetlands in areas where they have a large influence, especially the recharge wetlands along Swamp Creek. Other adjustments and modifications in the application of HSPF to Swamp Creek, the necessity for which became apparent during the model development, include: 1) routing adjustments to simulate ponding in the wetlands at several times during the year without dampening the hydrological response in the system; 2) the addition of acreage to the west of Rice Lake to account for the difference in areal extent of the groundwater watershed and surface water watershed (Figure 11), discussed previously in the “Hydrological Relations” section; 3) adjustment of the potential evapotranspiration (PET) coefficient to better reflect the actual evapotranspiration at the site; and 4) adjustment of infiltration through the upper and lower zone storage into the deep fraction (DEEPFR) to reflect the amount of water in the system in the upper layers and the minimal amount lost to the deep, inactive groundwater system. All of these points are tied into the conceptualized model of the study area, discussed in the “Hydrological Relations” section of this document.

Calibration Steps Applied in this Study

The steps and procedures used in running the HSPF model are: 1) utility software is used to build the Watershed Data Management (WDM) file, to add HSPF time-series input, and to build data sets to store HSPF time series output; 2) the User Control Input (UCI) file is compiled; and, 3) the expert system HSPEXP (Lumb et al., 1994) is used to assist in the calibration of HSPF. Model calibration also was facilitated by a software program (FITQUAL) which was developed for statistical analysis of monthly flows from this model. The following is a brief outline of the procedures; additional details can be found in Lumb et al. (1994).

UCI File

The HSPF UCI file contains all of the input to HSPF except the time series data. The UCI file contains the options, parameters, watershed characterization data, and information to control the interaction with the WDM file (*i.e*., the data sets for input and output time series data). The modeler changes the chosen parameter(s) in the UCI for each model run, runs the model, then analyzes the results to determine the next steps, based on whether the previous run resulted in better calibration results. The following is a brief outline of the contents of a UCI file for simulation of hydrology in a watershed:

GLOBAL block	Title and time span of the run
OPN Sequence block	List of model operations (land & stream segments) in order of simulation
PERLND block	Option flags and parameters defining pervious land segments
IMPLND block	Option flags and parameters defining impervious land segments
RCHRES block	Option flags and parameters defining river segments (reaches)
FTABLES block	Tables defining volume vs. discharge relation for the reaches
EXT SOURCES block	Specification of input (meteorologic) time series from WDM file
EXT TARGETS block	Specification of output time series to WDM file
SCHEMATIC block	Connectivity of the watershed segments and areas of land segments
MASS-LINK block	Specification of material (water) transfers between watershed segments

One of the most critical elements is the storing of the records from simulation into the WDM file which will then be combined with observed data to compute the statistical measures of calibration status in the HSPEXP program. The eight standard computed time series used with HSPEXP are:

1. simulated total runoff (inches),
2. simulated surface runoff (inches),
3. simulated interflow (inches),
4. simulated base flow (inches),
5. potential evapotranspiration (inches),
6. actual evapotranspiration (inches),
7. upper zone storage (inches),
8. lower zone storage(inches).

In addition, for this project, time series of lake and wetland water-surface elevations were computed and stored in the WDM for comparison with available observed data.

WDM file

The WDM file is a binary file that is used to store hydrologic, hydraulic, meteorologic, and water-quality data and is the repository for time series data associated with the model application. During simulations, HSPF obtains time series input data, such as rainfall from the WDM file; and writes output time series, such as streamflow to the file. Subsequent to simulation, utility programs access the time series for analysis and display. WDM files are created and maintained using several utility programs, including ANNIE (Flynn et al., 1995), IOWDM (Lumb et al., 1990), METCMP (unpublished), and SWSTAT(unpublished).

A WDM file contains multiple time series data sets. Each data set contains a specific type of data, such as streamflow at a specific site or air temperature at a weather station. Each data set contains attributes that describe the data, such as station identification, ID number, time step, latitude, and longitude.

The time series data for the WDM file for the study area were processed at the USGS District office in Madison, Wisconsin, with assistance from the USGS District office in Urbana, Illinois. This procedure included reformatting the data to WDM format, filling any missing periods with data from nearby stations (or other estimation methods), developing a composite rainfall record for the Swamp and Pickerel Creek watersheds, and creating hourly records of rainfall, solar radiation, and air temperature for input to the model.

The ANNIE program contains a set of procedures to organize, manipulate, and analyze data needed for hydrologic modeling and analysis. ANNIE enables the user to perform tasks related to data management, tabular and graphical presentation, and input preparation for hydrologic models interactively. These capabilities were utilized throughout the modeling process to aid the modelers via the creation of plots, for example, of flow and wetland ponding.

HSPEXP

The HSPEXP program was used to assist in calibrating HSPF for the Swamp Creek watershed. This expert system software was developed to assist less experienced modelers with calibration of a watershed model and to facilitate the interaction between the modeler and the modeling process. In this system, a set of conditions is developed for each of the major calibration phases: overall water balance, low/base flow, storms, and seasonal adjustments. To facilitate communication between the HSPEXP system and the user, seven error terms are computed by the system from simulated and observed streamflow time series:

1. error in total runoff volume for the calibration period,
2. error in the mean of the low-flow-recession rates based on the computed ratios of daily mean flow today divided by the daily mean flow yesterday for each day for the highest 30 percent (default) of the ratios less than 1.0,
3. error in the mean of the lowest 50 percent of the daily mean flows,
4. error in the mean of the highest 10 percent of the daily mean flows,
5. error in flow volumes for selected storms,
6. seasonal volume error, June-August runoff volume minus December-February runoff volume error, and
7. error in runoff volume for selected summer storms.

In addition, other statistics are computed and output by the program: the simulated surface runoff and interflow volumes, and the simulated actual evapotranspiration and the potential evapotranspiration. In this study, all these statistics were utilized except 6, the seasonal volume error, because for this watershed June - August and December - February both are low flow periods and this comparison of “seasons” really does not reveal basic shortcomings of the model.

Analysis of the influence of snow and snowmelt in the study area also was facilitated by the capabilities of the ANNIE program. An example is shown in Figure 12. The reduction in observed snow depth, which started at 26 to 36 inches, and then dropped to zero within a two week timeframe in April, coincided closely with a dramatic increase in observed discharge from 50 cfs to over 150 cfs in the same time interval. The measured precipitation at the same time was less than 0.1 inches on two or three days of the two week interval. As the watershed was further examined, this snowmelt pattern recurred consistently.

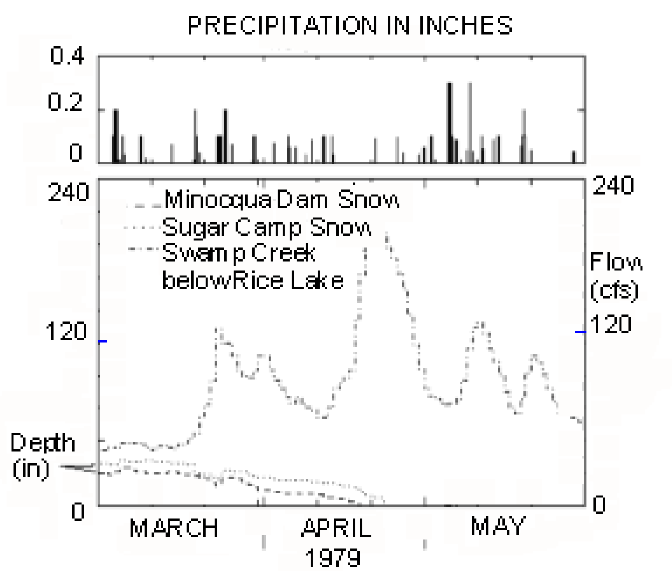


Figure 12. Typical relation between snowmelt and streamflow for the spring in the Swamp Creek watershed near Crandon, Wisconsin.

Storms were selected for inclusion in the HSPEXP computed statistics based on visual examination of observed hydrographs and storms with peak flows $\geq$ 60 cfs were used (Table 7). It should be noted that these values sometimes represented high snowmelt flows not necessarily related to high precipitation. Storms which were of a shorter runoff duration (2 - 3 days) were expanded for use in the model to a five day minimum runoff duration to better visualize the peak and recession of the storm plots.

As the model was run with each parameter adjustment, the statistical results for the error terms were reviewed to determine whether the parameter adjustment(s) had been successful in improving the agreement between observed and simulated results. Furthermore, after graphics and statistics were reviewed following a model run, the modeler could use the HSPEXP ADVISE option, which provides the user with advice on which model parameter(s) to change, the direction of change, and a brief explanation. The
ADVISE option was rarely utilized for this project, because the modelers rapidly gained an understanding of how to change parameter values to gain an improved simulation.

A statistical evaluation further indicated the progress of the model calibration by computing the statistics of the model fit-efficiency, correlation coefficient, average absolute error, number of errors < 10%, and number of errors < 25% for the monthly flows. The difference between simulated and observed flow, divided by observed flow, is computed as a percentage error for each month; and the absolute difference in total monthly flow is computed as the total error in each month. These errors were used to determine whether simulated flows were too high in the summer or some other season or month, so that parameters could be adjusted accordingly. The model-fit efficiency also was used as a strong indicator of overall model calibration quality.

Verification Criteria

Verification through temporal transposition involves application of the runoff relations calibrated for a given time period to a second independent time period and utilizing discharge, lake-level, and well water level data to evaluate the reliability of the calibrated HSPF model. Verification of the calibrated parameter set consisted of simulating the verification period (January 1978 through December 1981) for each watershed with application of the calibrated parameter set. An acceptable verification was achieved if statistical results from
the verification simulation were close to those statistical results for the best-fit model simulations for the calibration period, and graphical results from the verification simulation indicated no bias or trends in the simulated runoff. Verification utilized spatial transposition of the calibrated model as well as temporal transposition of the calibrated model. Verification through spatial transposition involves application of the model parameters calibrated for the Swamp Creek watershed to the Pickerel Creek watershed and utilizing lake-level and well water level data in the Pickerel Creek watershed (because no stream gage data are available) to evaluate the reliability of the calibrated HSPF model.

Table 7. Storms selected for calibration and verification of the Hydrological Simulation Program - Fortran model of Swamp Creek near Crandon, Wisconsin

Date verification period 19 storms	**Date calibration period 25 storms**
April 9-14, 1978	April 2-6, 1982
April 18-23, 1978	April 13-27, 1982
July 1-6, 1978 *	May 6-10, 1982
July 18-27, 1978 *	June 18-28, 1982 *
August 16-23, 1978 *	September 13-17, 1982
September 13-18, 1978	October 19-23,1982
March 19-30, 1979	November 11-15, 1982
April 14-May 1, 1979	March 3-10, 1983
May 19-24, 1979	April 12-16, 1983
June 16-21, 1979 *	May 7-11, 1983
July 10-19,1979 *	May 30-June 4, 1983
October 22-27, 1979	June 15-19, 1983 *
April 8-13, 1980	September 18-22, 1983
June 5-10, 1980 *	October 7-12, 1983
September 21-26, 1980	April 29-May 3, 1984
April 3-8, 1981	October 28-November 1, 1984
April 23-28, 1981	April 10-30, 1985
May 4-9, 1981	May 26-30, 1985
June 14-22, 1981*	July 5-9, 1985 *
	September 29-October 8, 1985
	October 31- November 4, 1985
	March 27-April 11, 1986
	April 14-18, 1986
	September 25-29, 1986
	October 11-16, 1986

*summer storms

RESULTS OF MODEL CALIBRATION

Model-calibration results for the Swamp Creek watershed above and below Rice Lake are presented in two time frames: results of best-fit calibration above Rice Lake are presented based on continuous, available data for 60 months (January 1982 - December 1986), and the results of the calibration below Rice Lake are presented for a 45-month period of record (January 1982 - September 1985). The grand total and annual water balances for the observed data and the best-fit calibration during the study are summarized in Table 8, along with the comparison of observed to simulated results. Statistical results for monthly flows of the best-fit calibrations are summarized in Table 9. The average absolute relative error (*aare*) is calculated:

$$aare = \frac{\sum \text{absolute relative error}}{\text{number of months}} \times 100$$

where:

$$\text{absolute relative error} = \frac{\text{simulated - measured}}{\text{measured}}$$

Best-fit model calibration of the Swamp Creek watershed above and below Rice Lake produced "good" results relative to nearly all of the criteria proposed in the QAPP (USEPA, 1998). Best-fit model calibration statistics were similar to results reported from similar studies that applied the Stanford Watershed Model or HSPF (Ligon and Law, 1973; Dinicola, 1989; Chiew et al., 1991; Price and Dreher, 1991; Duncker et al., 1995; Duncker and Melching, 1998; Jarrett et al., 1998; Zarriello and Ries, 2000). For simulations with the best-fit model-parameter sets, correlation coefficients for monthly flows were 0.8773 and 0.8303 above and below Rice Lake, respectively, and coefficients of model-fit efficiency for monthly flows were 0.6803 and 0.5393 above and below Rice Lake, respectively (Table 9). The targets for acceptable calibration and verification of monthly flows are a correlation coefficient greater than 0.85 (which was achieved above Rice Lake and nearly achieved below Rice Lake) and a coefficient of model-fit efficiency greater than 0.80 (which was not met). The failure to achieve the model-fit efficiency criterion occurred because the variability of monthly flows in Swamp Creek is small relative to most streams modeled with HSPF (e.g., Duncker et al., 1995; Duncker and Melching, 1998; Jarrett et al., 1998). With a small observed monthly variability, one or two poorly simulated months distorts the fraction of monthly variability explained by the model. To illustrate this, for Swamp Creek above Rice Lake, if the errors for 3 of the 60 months (March, August, and September 1984) are reduced to 0, the coefficient of model-fit efficiency rises from 0.6803 to 0.7240. More dramatically, for Swamp Creek below Rice Lake, if errors for 4 of 45 months (July 1982, April 1983, March and September 1984) are reduced to 0, the coefficient of model-fit efficiency changes from 0.5393 to 0.7254. Note that some are months in which snowmelt contributes significantly to runoff. This demonstrates that a few poorly simulated months caused the model-fit efficiency not to meet the acceptance criterion. The initial goals of 0.8000 for model-fit efficiency and 0.8500 for correlation coefficient were acceptable for areas where snowmelt is a major factor and proximate meteorological data are sparse. The average absolute errors in the simulated monthly flows were 17.95 and 20.23 percent for Swamp Creek above and below Rice Lake, respectively.

Targets for error criteria for total volume, low flow recession, 50% lowest flows, 10% highest flows, storm volumes, and summer storm volume were met as shown in Table 10, except for low flow recession and storm runoff volume above Rice Lake. The statistical evaluation between the above and below Rice Lake locations indicates that the overall fit quality for each location is very similar.

Using the criteria of Donigian et al. (1984, p. 114), the best-fit simulations provided less than 10 percent error results for watershed total water balances and 10 -15 percent error in the annual water balances. The margin of error for total water balances was within -6.80 percent in Swamp Creek above Rice Lake, and 2.60 percent below Rice Lake (Table 10). Annual water balances were simulated with absolute errors from 5 to 18 percent in the Swamp Creek watershed above and below Rice Lake, calculated from Table 8. Many of the greater absolute percentage errors in the annual and monthly water balances reflect years and months with relatively low runoff. These periods yield absolute errors with large percentage differences but fairly small actual differences. The grand total water balance and annual water balances were most sensitive to changes in the upper zone nominal storage parameter (UZSN) and the parameter controlling recharge to deep aquifers, DEEPFR. However, based on hydrogeological information in the study area, only a very small portion of the deep groundwater does not discharge to Swamp Creek in the study area, thus, DEEPFR must be small.

Problems in the calibration process have also been encountered in other studies, but the difficulties appear to be unique in each watershed. Some of the situations encountered were:

1) The observed snow depth data indicated that snowmelt occurred a week or two weeks before the runoff hydrograph indicated a snowmelt-related rise. Thus, it was difficult to calibrate the snowmelt simulation properly and to match observed flows during the snowmelt period of March and April.
2) It was not always possible to meet the measured recession rate within the specified criterion of 0.03.
3) As discussed in the first paragraph of this section, the criterion for the model-fit efficiency could not be met.
4) Many attempts to get the results to show “ponding” (ground water elevations greater than the land surface elevation) by changing the surface runoff exponent (SREXP) were not effective, nor was changing the hourly recession constant (SRRC). Changes in wetland FTABLES proved to be effective.

The daily stream flow hydrographs simulated using the calibrated parameters are compared to the observed flows for the Swamp Creek watershed above and below Rice Lake in Figures 13 and 14. Simulated and observed monthly hydrographs are shown in Figures 15A - B. Close reproduction of the observed runoff-duration curves (Figures 16A - B) indicates that the best-fit calibration parameter sets provide an acceptable simulation of rainfall-runoff relations on the Swamp Creek watershed in Forest County, Wisconsin. For flows exceeded 90% of the time, the match is close. The observed runoff-duration curves depart from simulated curves at flows below about 20-25 cfs.

Table 8. Observed and simulated Hydrological Simulation Program - Fortran values of annual and grand total runoff in inches for the Swamp Creek watershed above and below Rice Lake, and comparison of simulated values to observed data, at Mole Lake Reservation, Wisconsin.

Swamp Creek Calibration	**Values**	**1982**	**1983**	**1984**	**1985**	**1986**	**Grand Total**	**Average**
Swamp Creek above Rice Lake (inches)	observed simulated	9.94 9.73	12.25 12.87	9.65 8.07	13.06 10.73	11.78 11.40	56.675 52.800	11.34 10.56
Ratio of sim/obs. Swamp Creek above Rice Lake	simulated/ observed	0.979	1.051	0.836	0.822	0.968	-----	0.93
Swamp Creek below Rice Lake (inches)	observed simulated	9.12 9.99	11.36 13.01	9.33 8.05	8.28 (¾yr.) 7.58 (¾yr.)	na	38.09 39.07	10.21 10.29 (est. 4yrs)
Ratio of sim/obs. Swamp Creek below Rice Lake	simulated/ observed	1.095	1.145	0.863	0.915(¾yr.)	na	-----	1.08 (est. for 4 years)

Table 9. Model-Calibration statistics for monthly flows for the Swamp Creek watershed above and below Rice Lake at Mole Lake Reservation, Wisconsin, simulated with application of the Hydrological Simulation Program - Fortran for a 60-month calibration period above and 45-month calibration period below (January 1982 - December 1986 and January 1982 - September 1985, respectively).

Swamp Creek Calibration	**Coefficient of Model Fit Efficiency**	**Correlation Coefficient**	**Average absolute relative error**	**Number of months when the difference between simulated and observed average monthly discharge was < 10%**	**Number of months when the difference between simulated and observed average monthly discharge was < 25%**
Swamp Creek above Rice Lake	0.6803	0.8773	17.95	17 (of 60 months)	46 (of 60 months)
Swamp Creek below Rice Lake	0.5393	0.8308	20.23	8 (of 45 months)	35 (of 45 months)

Table 10. Statistics for the criteria used in the hydrologic simulation of the Swamp Creek watershed above and below Rice Lake at Mole Lake Reservation, Wisconsin, obtained with the Hydrological Simulation Program - Fortran applied to a 60-month calibration period above and 45-month calibration period below (January 1982 - December 1986 and January 1982 - September 1985, respectively).

Swamp Creek Calibration	**Total volume (in.)**	**Low flow recession rate**	**50% lowest flows (in.)**	**10% high flows (in.)**	**Total Storm volumes (in.)**	**Summer storm volumes (in.)**
Above Rice Lake obs. & sim.	56.675 (obs) 52.810 (sim)	0.950 0.990	18.437 16.690	12.761 11.920	11.254 9.060	1.085 0.900
Below Rice Lake obs. & sim.	38.080 (obs) 39.070 (sim)	0.960 0.990	12.944 12.670	7.692 8.340	6.269 5.870	0.936 0.900
Error above Rice Lk. (%)	-6.8	-0.04	-9.5	-6.6	-19.5	-17.1
Error below Rice Lk. (%)	2.6	-0.03	-2.1	8.4	-6.4	-3.8
Error criteria (%)	±10.00	±0.03	±10.00	±15.00	±15.00 *	±20.00 *

* These criteria were tightened from the HSPEXP (Lumb et al., 1994) default criteria of ±20.00% and ±50.00, respectively.

Figures 17 (A -D) show water-surface elevations for four wells located in wetlands in the Swamp Creek watershed. For the three year period 1984-1986, only nine water-surface elevation measurements were made at each of these wells. As shown in Figures 17(A) and 17(C), respectively, the available data for Well WP-2U (Segment 80) and Well WP-6U (Segment 180) show only about 0.1 to 0.2 ft of variability in the water-surface elevation (with the exception of the outlier in May 1984 at Well WP-2U). Whereas for Well WP-4U (Segment 100) a variation of about 0.5 to 0.6 ft in water-surface elevation is shown in the available data in Figure 17(B). It seems that these relatively small variations are an artifact of the very infrequent sampling rather than the true fluctuations in wetland water-surface elevations over a 3-year period. Data from Well WP-7U (Segment 190) indicates nearly 1.5 ft of water-surface-elevation fluctuations and has very good agreement with the simulated water-surface-elevation fluctuations (Figure 17(D)). These last results give some confidence that HSPF is realistically simulating water-surface-elevation fluctuations in at least some wetlands in the Swamp Creek watershed. When the model was recalibrated for this iteration of the document, the plots remained essentially the same. On the nine days of measured values, the corresponding simulated values had some minor changes of approximately 0.1 ft to 0 ft.

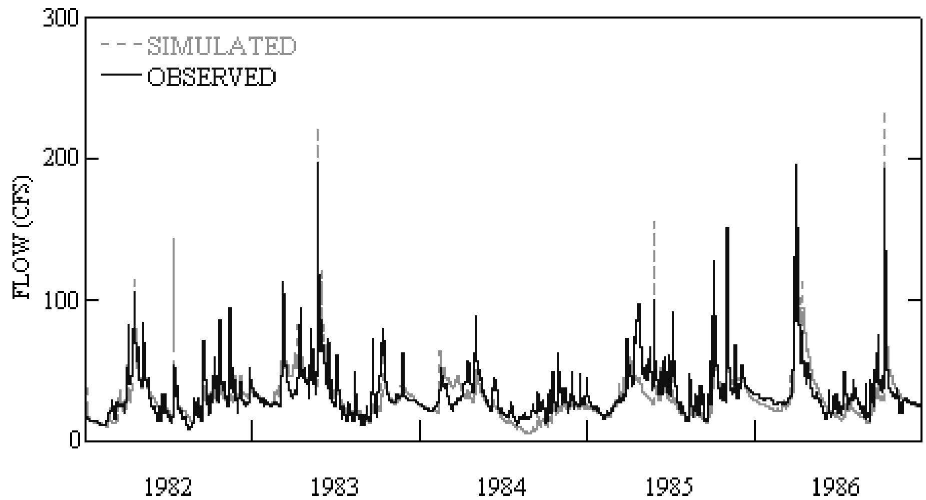


Figure 13. Daily flows observed and simulated with the Hydrological Simulation Program - Fortran for Swamp Creek above Rice Lake at Mole Lake Reservation, Wisconsin, for 1982 - 1986.

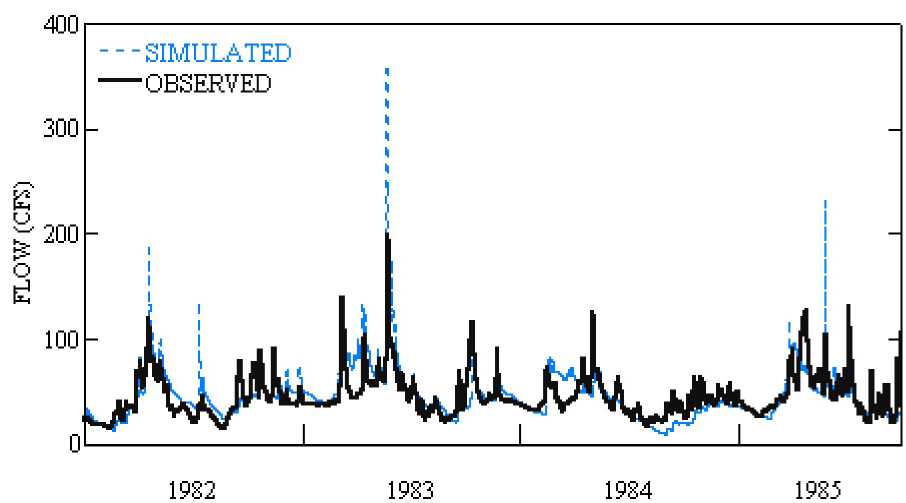


Figure 14. Daily flows observed and simulated with the Hydrological Simulation Program - Fortran for Swamp Creek below Rice Lake near Mole Lake Reservation, Wisconsin, for 1982 - 1985.

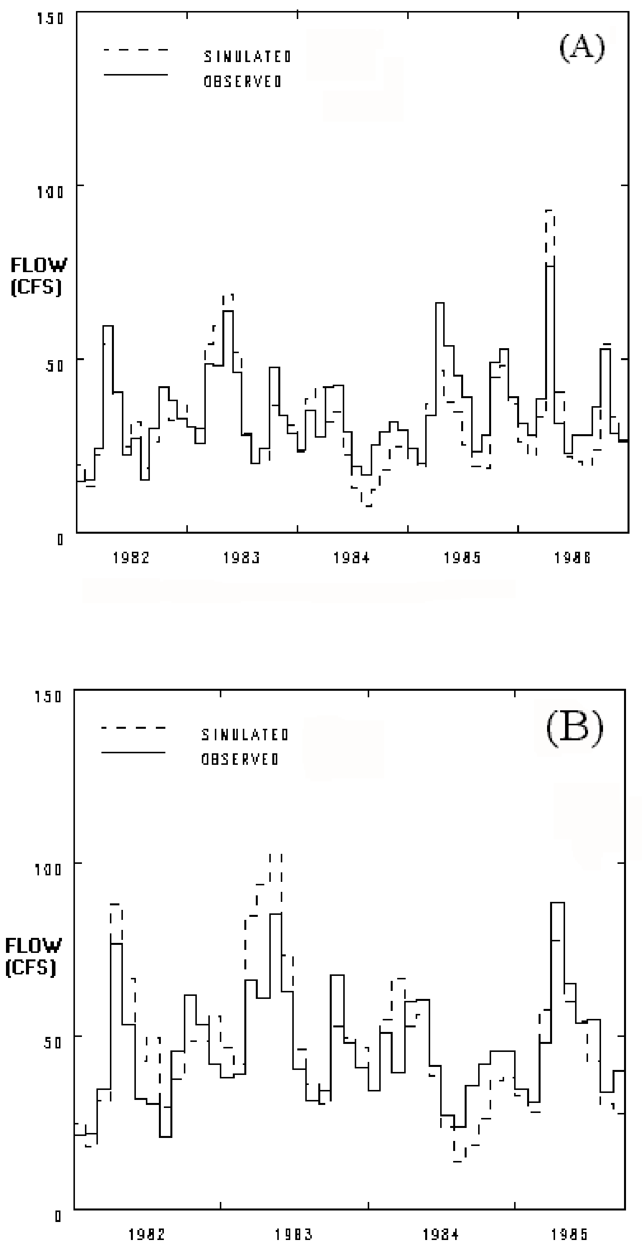
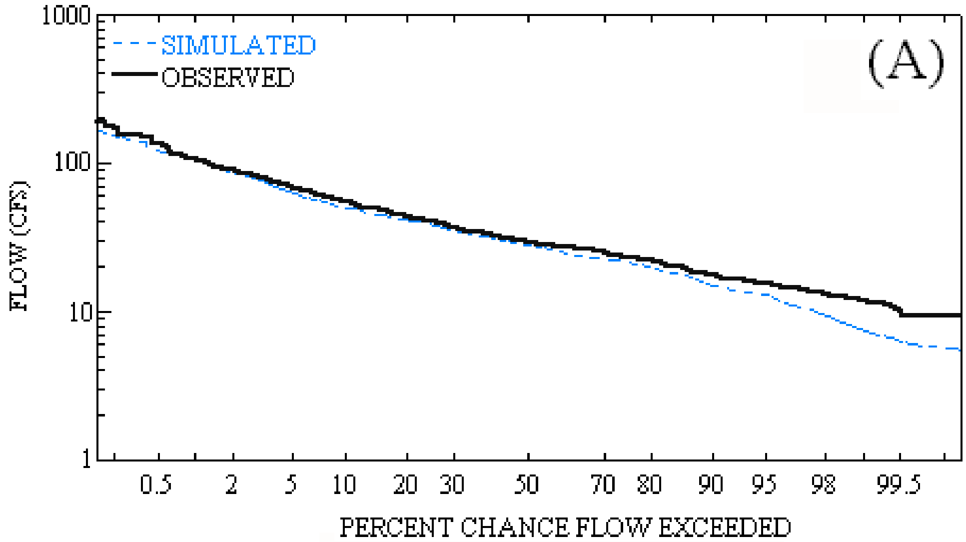


Figure 15. Monthly flows observed and simulated with the Hydrological Simulation Program - Fortran for (A) Swamp Creek above Rice Lake for 1982 - 1986 and (B) Swamp Creek below Rice Lake near Mole Lake Reservation, Wisconsin, for 1982 - 1985.



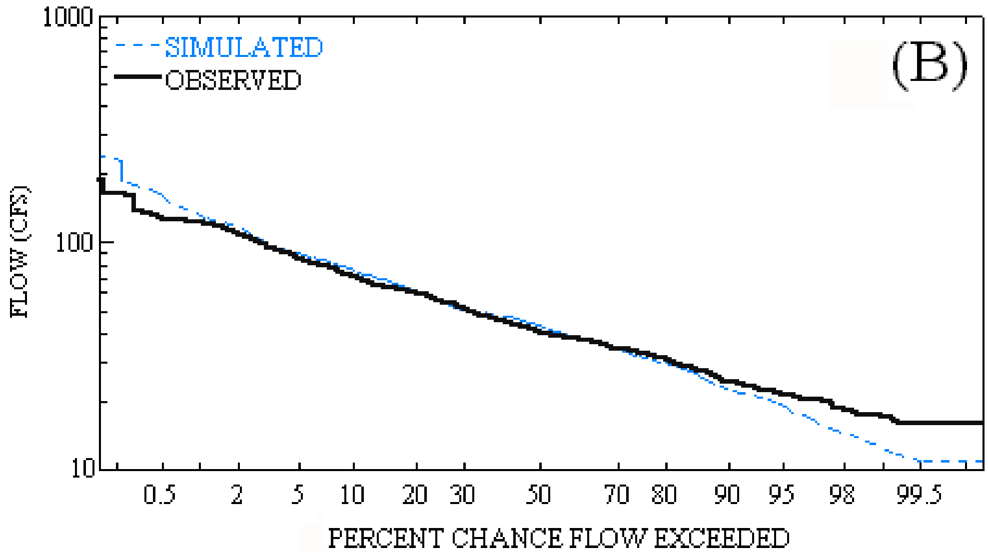


Figure 16. Daily flow duration curves observed and simulated with the Hydrological Simulation Program - Fortran for (A) Swamp Creek above Rice Lake for 1982 - 1986 and at (B) Swamp Creek below Rice Lake near Mole Lake Reservation, Wisconsin, for 1982 - 1985.

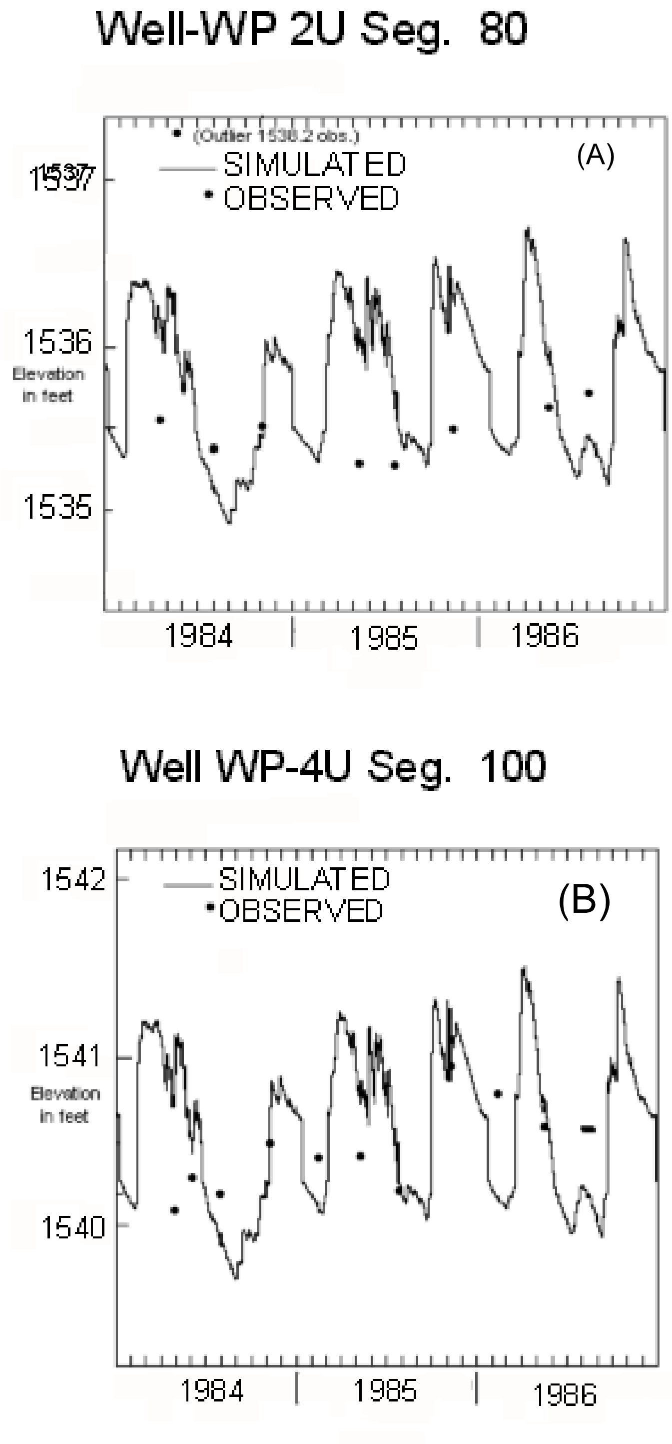
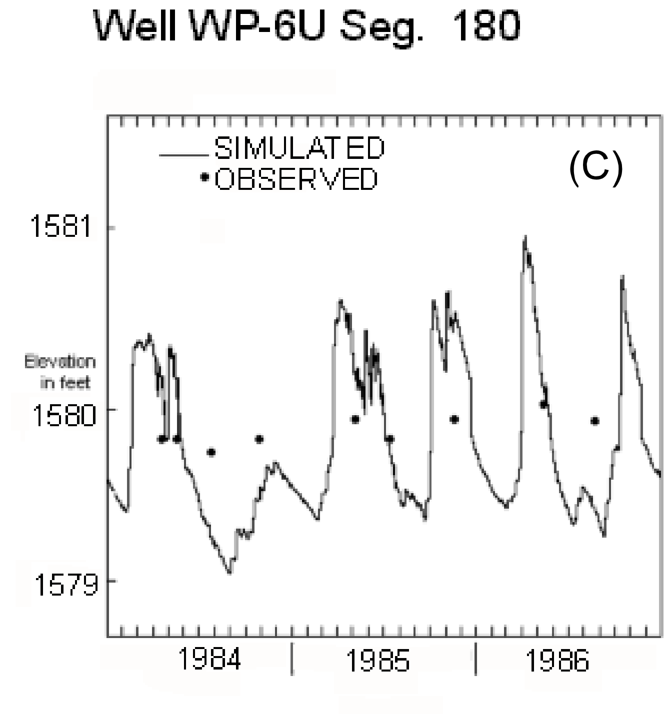


Figure 17. Wetland well water-surface elevations observed and simulated with the Hydrological Simulation Program - Fortran for (A) Well WP-2U in Segment 80, (B) Well WP-4U in Segment 100 (con't next page).



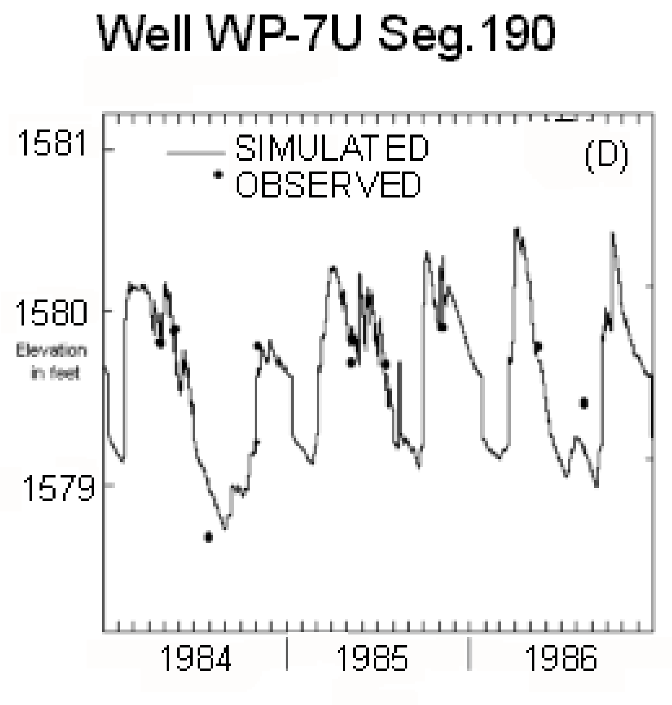


Figure 17 (con't). Wetland well water-surface elevations observed and simulated with the Hydrological Simulation Program - Fortran for (C) Well WP-6U in segment 180, and (D) Well W -7U in segment 190.

RESULTS OF MODEL VERIFICATION

Swamp Creek Temporal Verification

Model verification for the Swamp Creek watershed above and below Rice Lake produced “fair” results relative to nearly all of the criteria proposed in the QAPP (USEPA, 1998). For simulations with the best-fit model-parameter sets from the calibration, correlation coefficients for monthly flows were 0.8124 and 0.8222 above and below Rice Lake, respectively, and coefficients of model fit efficiency for monthly flows were 0.5218 and 0.5266 above and below Rice Lake, respectively (Table 11). The targets for acceptable verification of monthly flows are correlation coefficients greater than 0.85 and coefficients of model-fit efficiency greater than 0.80. These targets were not achieved. As was found for the calibration period, this occurred because the variability of monthly flows in Swamp Creek is small relative to most streams and so the basic monthly variability is small. With a small observed monthly variability, one or two poorly simulated months greatly distorts the fraction of monthly variability explained by the model. As noted in the calibration of Swamp Creek above Rice Lake, if the errors for 3 of the 48 months in the verification period (March 1980, September and December 1981) are reduced to 0, the coefficient of model-fit efficiency changes from 0.5218 to 0.5539. For Swamp Creek below Rice Lake, 3 of 48 months (February 1978, March 1979 and 1980) were reduced to 0 and the coefficient of model-fit efficiency changes from 0.5266 to 0.6476. The correlation coefficient above and below Rice Lake changed little with the omission of the outliers in the statistics, less than 0.05. Average absolute errors in the simulations were 26.46 and 26.16 percent for Swamp Creek above and below Rice Lake, respectively.

Table 11. Model-verification statistics for monthly flows for the Swamp Creek watershed above and below Rice Lake at Mole Lake Reservation, Wisconsin, simulated with application of the Hydrological Simulation Program - Fortran for a 48-month verification period (January 1978 - December 1981).

Swamp Creek Verification	Coefficient of Model Fit Efficiency	Correlation Coefficient	Average absolute relative error (%)	Number of mos. when the difference between sim. and obs. average monthly discharge was < 10%	Number of mos. when the difference between sim. and obs. average monthly discharge was < 25%
Above Rice Lake	0.5218	0.8124	26.46	14 (of 48 months)	24 (of 48 months)
Below Rice Lake	0.5266	0.8222	26.16	13 (of 48 months)	27 (of 48 months)

Targets for error criteria for total volume, 50% lowest flows, 10% highest flows, storm volumes, and summer storm volume were met as shown in Table 12. The target error criteria for low flow recession rate was slightly exceeded (0.04 relative to a criterion of 0.03), but this was no worse than the calibration result for Swamp Creek above Rice Lake. The statistical evaluation between the above and below Rice Lake locations indicates that the overall fit quality for each location is very similar. The daily stream flow results for the calibrated model parameters is compared to observed flow for the Swamp Creek watershed above and below Rice Lake in Figures 18 and 19, respectively. Simulated and observed monthly discharges are shown in Figure 20.

Close reproduction of the observed runoff-duration curves for the verification period (Figure 21) indicates that the best-fit calibration parameter set, used for the verification period, provides an acceptable simulation of rainfall-runoff relations on the Swamp Creek watershed in Forest County, Wisconsin. The observed runoff-duration curve departs from both simulated curves at a flow of about 30 cfs. The verification plots differ from the calibration curves (Figure 16) in that there is a greater difference between the observed and simulated values for the low flow portions of the curve. A possible explanation for this difference is that low flows have greater statistical errors when comparing simulated and observed values.

Table 12. Statistics for the criteria used in the hydrologic simulation of the Swamp Creek watershed above and below Rice Lake at Mole Lake Reservation, Wisconsin, obtained with the Hydrological Simulation Program - Fortran applied to a 48-month verification period (January 1978 - December 1981).

Swamp Creek Verification	**Total volume (in.)**	**Low flow recession rate**	**50% lowest flows (in.)**	**10% high flows (in.)**	**Total Storm Volume (in.)**	**Summer storm volume (in.)**
Above Rice Lake obs. & sim.	40.828 40.120	0.950 0.990	12.409 11.210	9.891 10.410	9.819 9.24	3.472 3.650
Below Rice Lake obs. & sim.	40.316 40.490	0.950 0.990	12.508 11.600	9.631 10.300	9.522 8.980	3.268 3.410
Error above Rice Lk. (%)	-1.7	-0.04	-9.7	5.2	5.9	5.1
Error below Rice Lk. (%)	0.4	-0.04	-7.3	7	-5.7	4.3
Error criteria (%)	±10.00	±0.030	±10.00	±15.00	±15.00	±20.00

* These criteria were tightened from the HDPEXP (Lumb et al., 1994) default criteria of ±20.00% and ±50.00, respectively.

Table 13. Observed and simulated using the Hydrological Simulation Program - Fortran annual and grand total runoff for the Swamp Creek watershed above and below Rice Lake at Mole Lake Reservation, Wisconsin, applied to a 48-month verification period (January 1978 - December 1981).

Swamp Creek Verification	**verification**	**1978**	**1979**	**1980**	**1981**	**Grand Total**	**Average**
Swamp Creek Above Rice Lake (inches)	observed simulated	10.15 8.93	12.51 13.68	9.13 10.53	9.05 6.98	40.828 40.12	10.21 10.03
Ratio of sim/obs Swamp Creek Above Rice Lake	simulated/ observed	0.88	1.09	1.15	0.77	-----	0.97
Ration of sim/obs Swamp Creek Below Rice Lake (inches)	observed simulated	10.07 8.92	12.80 13.60	8.76 10.88	8.69 7.09	40.316 40.49	10.08 10.12
Ratio of sim/obs Swamp Creek Below Rice Lake	simulated/ observed	0.89	1.06	1.24	0.82	-----	1

Following the criteria of Donigian et al. (1984, p. 114), the best-fit simulations provided less than 10 percent error results for watershed total water balances and 10 - 15 percent error, or 15 - 25 percent error annual water balances (Table 13) for the verification period. The margin of error for total water balances was within -1.70 percent in Swamp Creek above Rice Lake, and 0.40 percent below Rice Lake. Annual water balances were simulated with absolute errors from 6 to 24 percent in the Swamp Creek watershed above and below Rice Lake. As in calibration, many of the greater absolute percentage errors in the annual and monthly water balances in verification reflect years and months with relatively low amounts of runoff. These periods yield absolute errors with large percentage differences but fairly small actual differences.

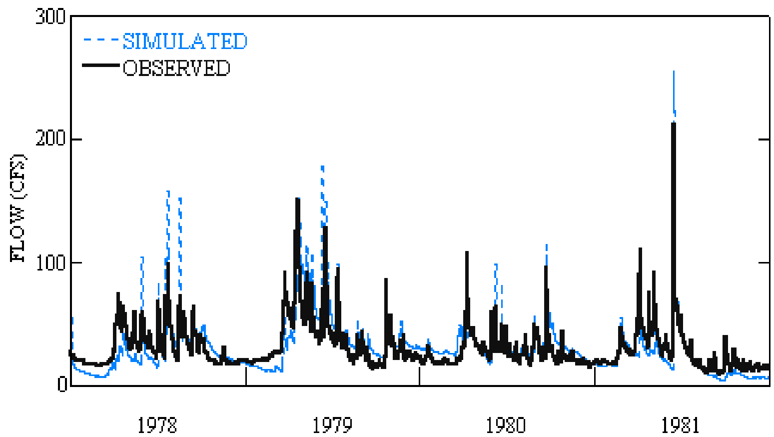


Figure 18. Daily flows observed and simulated with the Hydrological Simulation Program - Fortran for Swamp Creek above Rice Lake at Mole Lake Reservation, Wisconsin, for 1978 -1981.

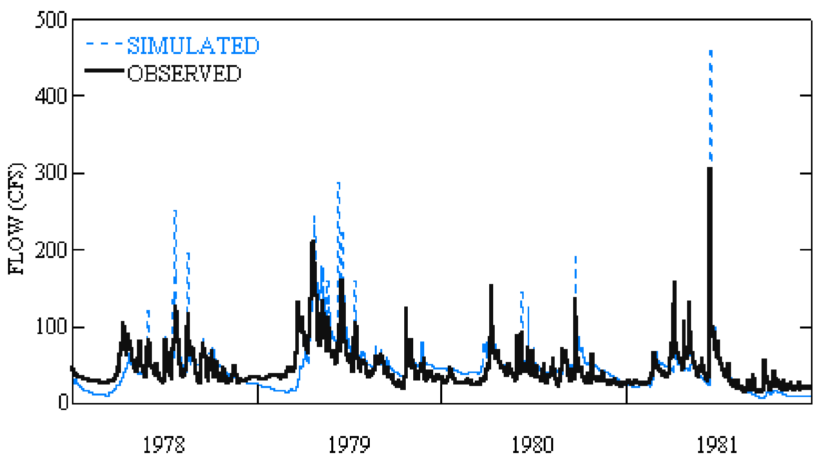
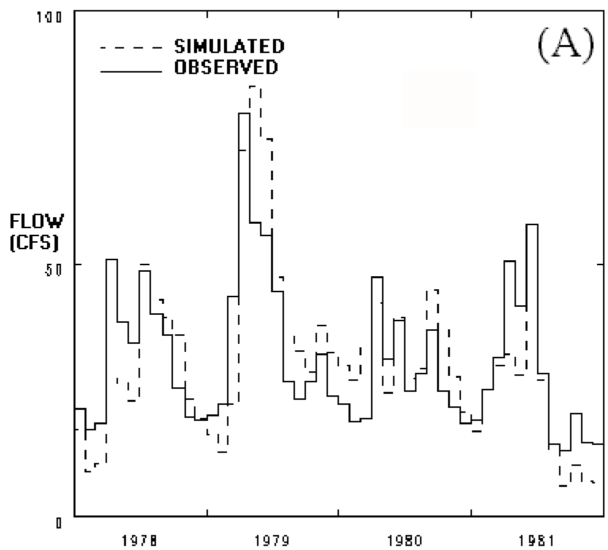


Figure 19. Daily flows observed and simulated with the Hydrological Simulation Program - Fortran for Swamp Creek below Rice Lake at Mole Lake Reservation, Wisconsin, for 1978 -1981.



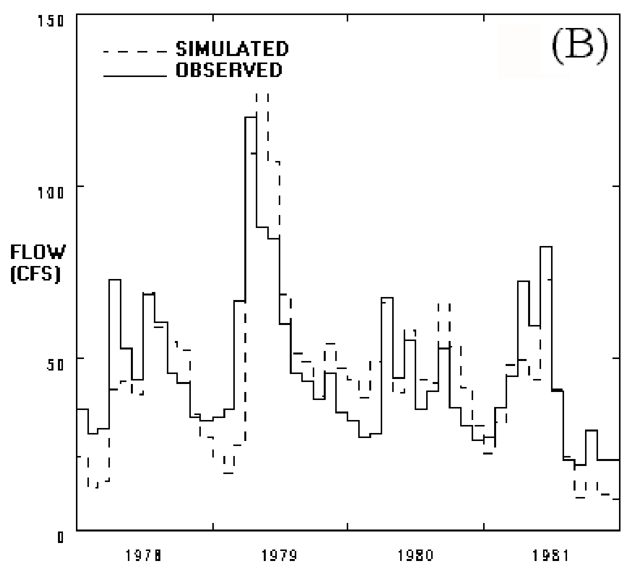


Figure 20. Monthly flows observed and simulated with the Hydrological Simulation Program - Fortran for (A) Swamp Creek above Rice Lake and (B) Swamp Creek below Rice Lake near Mole Lake Reservation, Wisconsin, applied to a 48-month verification period (January 1978 - December 1981).

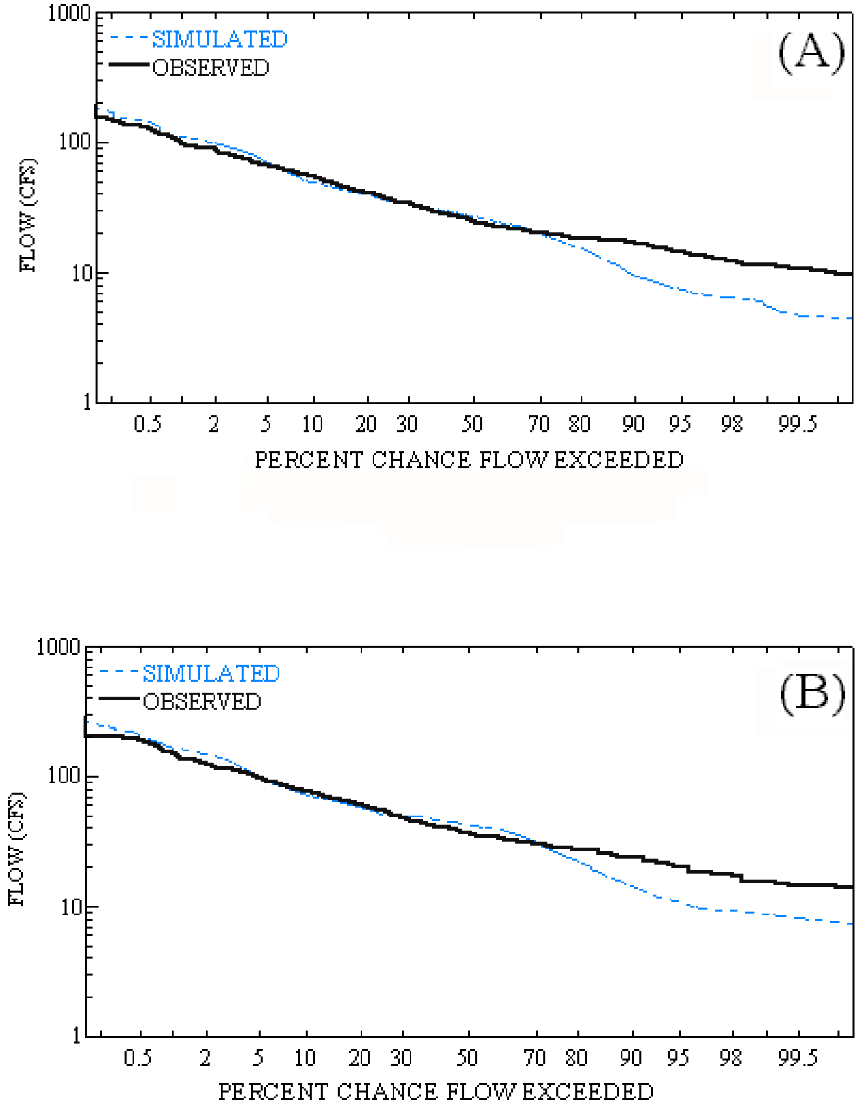
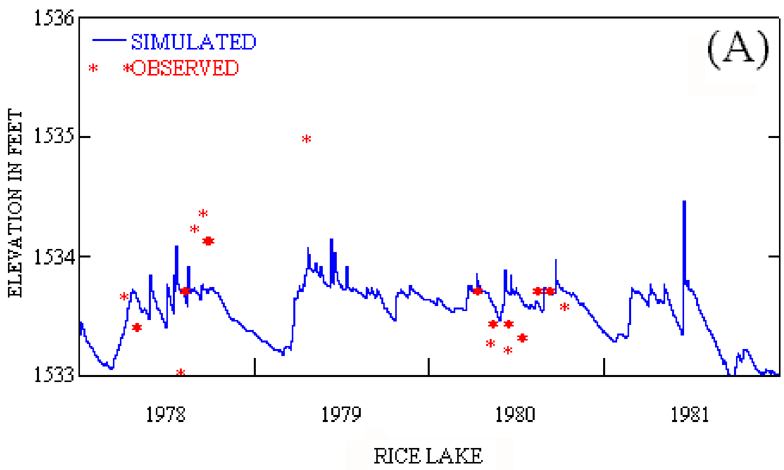


Figure 21. Daily flow duration curves observed and simulated with the Hydrological Simulation Program - Fortran for (A) Swamp Creek above Rice Lake and (B) Swamp Creek below Rice Lake near Mole Lake Reservation, Wisconsin, Applied to a 48-month verification period (January 1978 - December 1981).

Figures 22 (A) and (B) show results in the Swamp Creek watershed in comparing observed and simulated water-surface elevation for two lakes, Rice Lake and Ground Hemlock Lake in the verification period 1978-1981. The agreement between observed and simulated water-surface elevations for Rice Lake is at times very good and at other times very poor. This result is difficult to explain given the reasonable simulation of flows into and out of Rice Lake. Given that the USGS streamflow data are thoroughly quality assured, it seems that some of the water-surface elevation data for Rice Lake may be unreliable. The agreement between observed and simulated water-surface elevations for Ground Hemlock Lake is good, but only for a small number of data points.



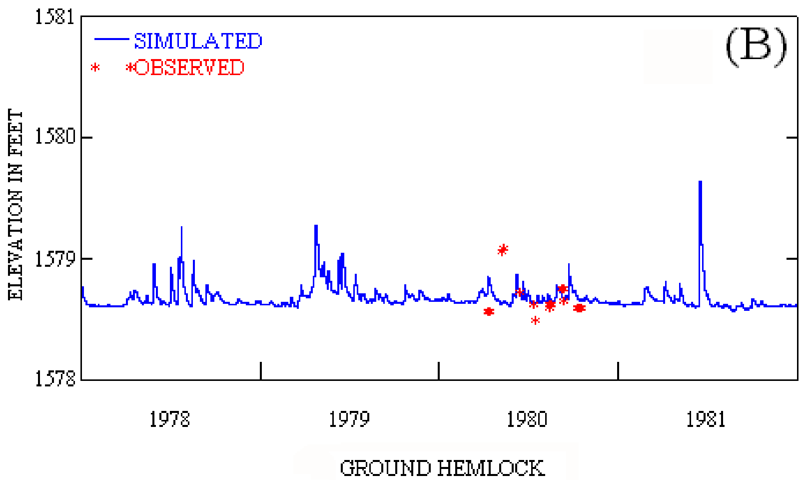


Figure 22. Lake water-surface elevations (stage) observed and simulated with the Hydrological Simulation Program - Fortran for (A) Rice Lake at Mole Lake Reservation, Wisconsin, and (B) Ground Hemlock Lake near Crandon, Wisconsin, for 1978 - 1981.

Pickerel Creek Spatial Verification

Since continuous discharge data are not available for the Pickerel Creek drainage area, verification had to be done by comparing observed lake level and wetland water-level data with simulated results. For the same reason, the statistical programs within HSPEXP could not be utilized. The Pickerel Creek watershed model simulated the period 1971 through 1995 using the best-fit parameter values from Swamp Creek.

A flow duration curve has been developed by the USGS for the Pickerel Creek watershed based on thirteen measurements on Pickerel Creek below Rolling Stone Lake, and correlation with measurements on the Wolf River at Langlade. It was felt that the correlation of the 14.7 mi^2 Pickerel Creek watershed with the 462 mi^2 Wolf River watershed was not a sufficiently accurate test for an HSPF model calibrated to 5 years of daily flows in Swamp Creek.

Observed and simulated lake levels within the Pickerel Creek watershed are shown in Figures 23-27 for Rolling Stone, Little Sand, Duck, Deep Hole, and Skunk Lakes, respectively. The solid line on the plots represents the Pickerel Creek watershed simulated baseline using Swamp Creek calibration parameters, and the points are observed data. A quick visual comparison of observed versus simulated water-surface elevations indicates good general agreement. However, there are examples of poor agreement between observed and simulated values. For example, Figure 25(A) shows the poor agreement between observed and simulated water-surface elevations fo Duck Lake in 1985, and Figure 26(A) shows the poor agreement between observed and simulated water-surface elevations for Deep Hole Lake in 1978.

Figures 24, 25(B), 26(B), and 27 illustrate the results of “fitting” of seepage from these lakes as discussed in detail in the section “HSPF Seepage Methodology”, and show the comparison of observed and simulated lake water-surface elevations. Figures for four of the lakes show the entire period during which observations were taken between 1976 and 1995. Because the “fitted” seepage was bounded by the results of previous lake water balance studies by measurement and by simulation with the LAK2 module of MODFLOW, the comparison of observed and simulated stages provides some assurance that HSPF reasonably simulates the rainfall-runoff process in the Pickerel Creek watershed.

The very good agreement between simulated and observed values for Rolling Stone Lake (only four years of observed measurements taken) indicates that the calibrated parameter set is particularly well suited to simulating the rainfall-runoff process at a slightly larger watershed scale (Figure 23). That is, the accuracy of the HSPF simulation improves as the size of the watershed considered approaches that of the calibration watershed. Further, Rolling Stone Lake did not have the same seepage fitting applied to its baseline (for reasons to be discussed later) yet has the very good fit between observed and simulated values.

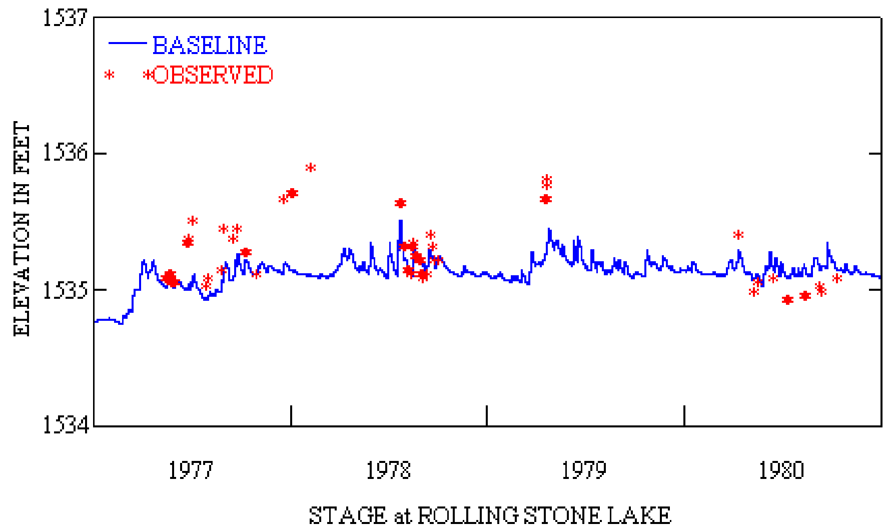


Figure 23. Water-surface elevation observed and simulated with the Hydrological Simulation Program - Fortran for Rolling Stone Lake near Crandon, Wisconsin for 1977-1980.

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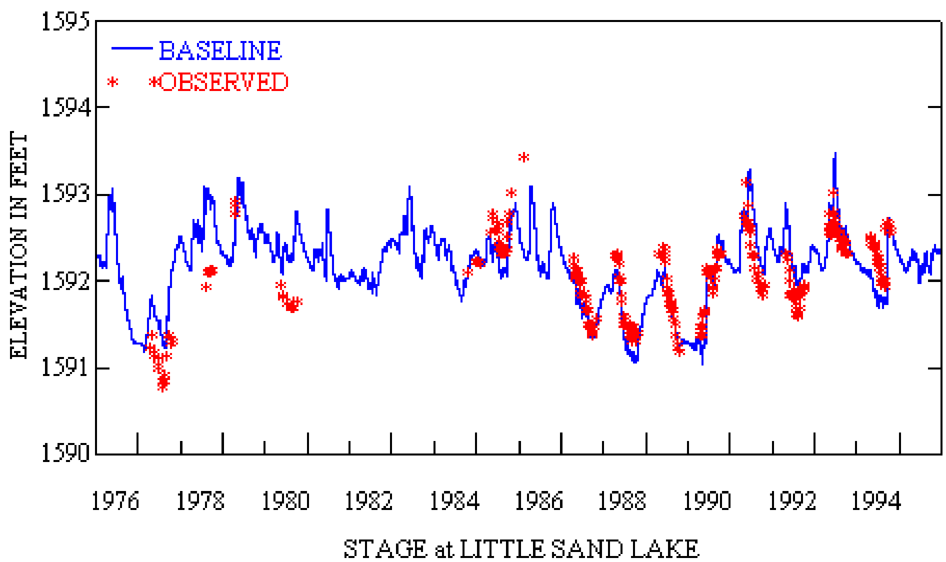
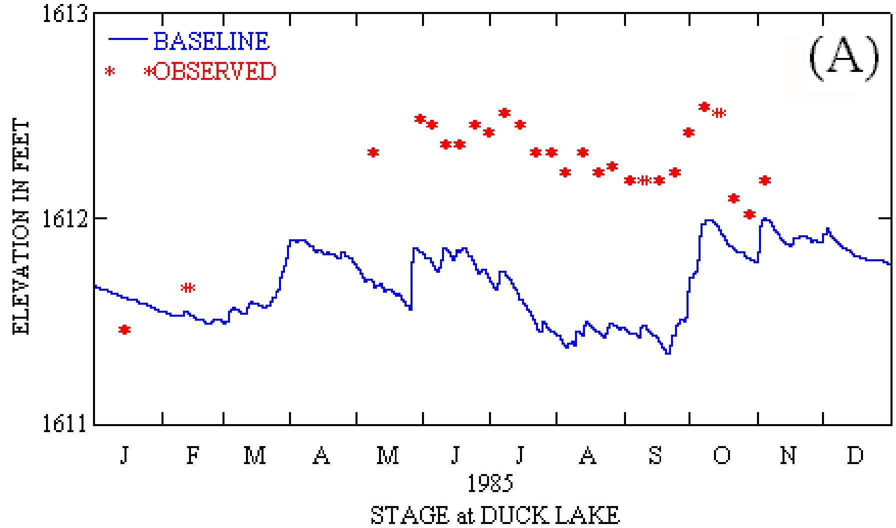


Figure 24. Water-surface elevation observed and simulated with the Hydrological Simulation Program - Fortran for Little Sand Lake near Crandon, Wisconsin, with seepage adjustment for 1976 -1995.



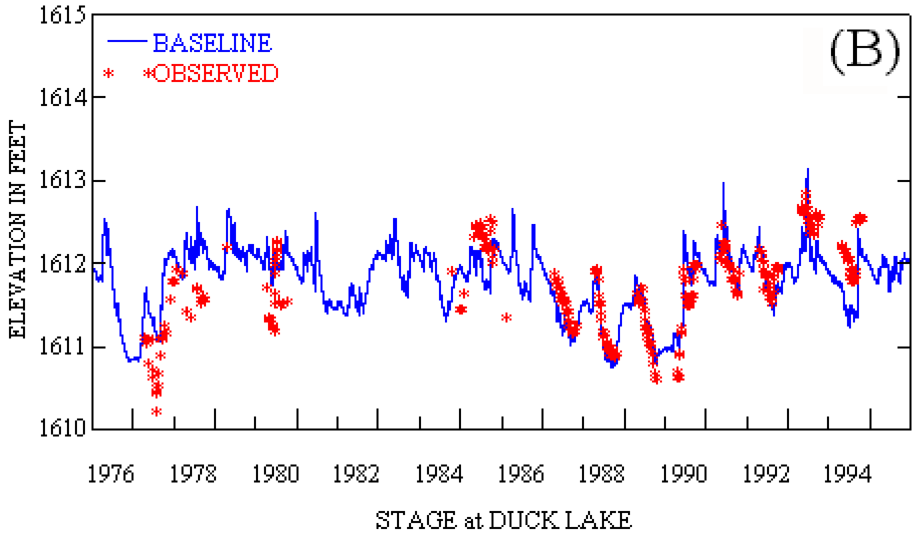


Figure 25. Water-surface elevation observed and simulated with the Hydrological Simulation Program - Fortran for Duck Lake near Crandon, Wisconsin for (A) 1985, and (B) with seepage adjustment for 1976-1995.

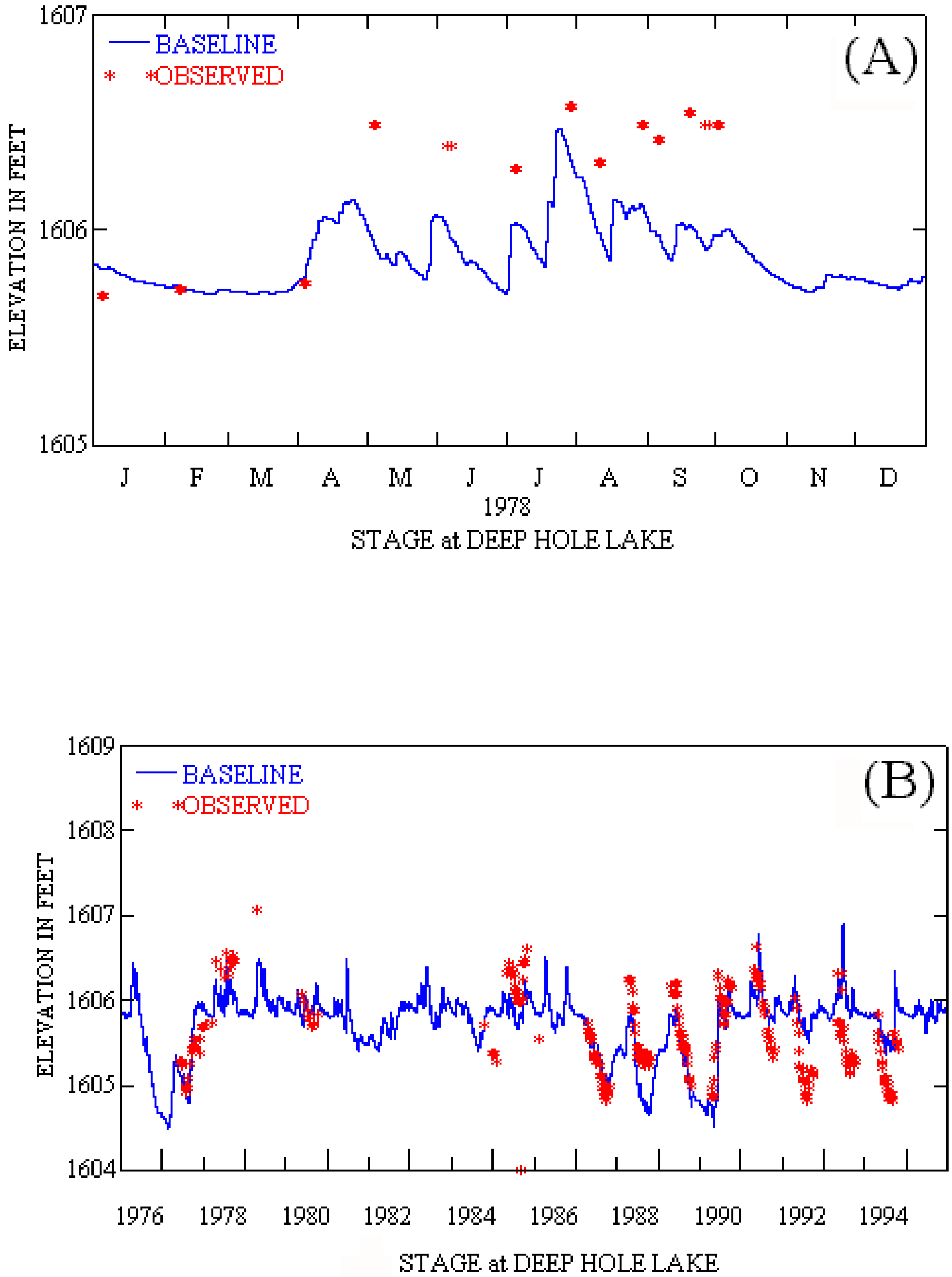


Figure 26. Water-surface elevation observed and simulated with the Hydrological Simulation Program - Fortran for Deep Hole Lake near Crandon, Wisconsin for (A) 1978, and (B) with seepage adjustment for 1976 -1995.

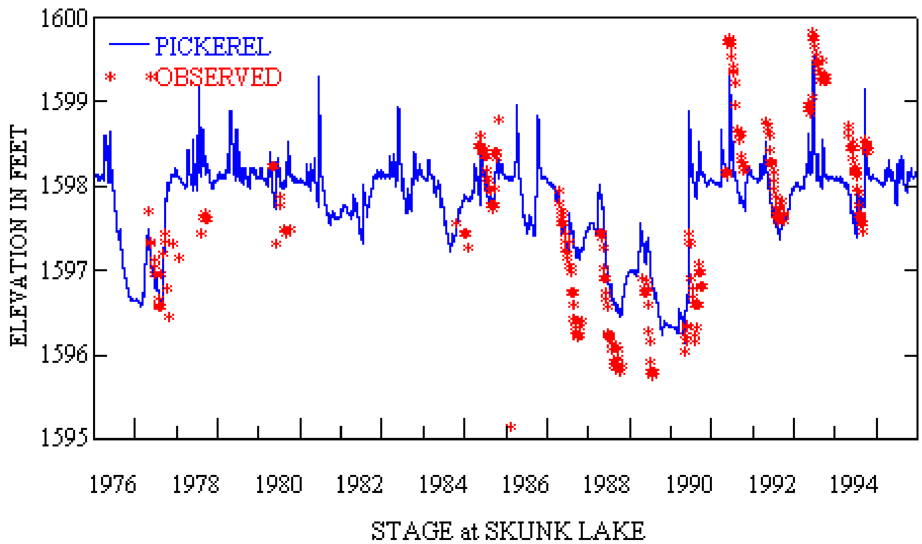


Figure 27. Water-surface elevation observed and simulated with the Hydrological Simulation Program - Fortran for Skunk Lake near Crandon, Wisconsin, with seepage adjustment for 1976 -1995.

Summary Comments

Thomann (1982) recommended that a verification data set should represent the system under a sufficiently perturbed condition to provide an adequate test of the model. This criterion was partially met in this study of HSPF applied to the vicinity of the proposed Crandon Mine. The temporal verification period involved substantially reduced annual runoff (approximately 1.1 inches or 10 percent less) than the calibration period. Yet nearly all the HSPEXP fit criteria were met both above and below Rice Lake. Further, while the monthly fit statistics did not achieve all the acceptance levels set forth in the QAPP, these values were not substantially worse than some of the values obtained during calibration. The spatial verification also yielded interesting results. Observed lake levels were matched extremely well in the Pickerel Creek watershed primarily for time periods outside of the1978-1986 verification/calibration periods in Swamp Creek. These good verification results under substantially different conditions from the calibration support the reliability of the HSPF model for simulation of the rainfall-runoff process. Finally, the testing of the HSPF output with respect to measured flow, lake stage, and wetland water levels also provides a thorough evaluation of the usefulness of HSPF for simulation of changes in surface hydrology.

Figure 28 plots the difference (error) between simulated minus observed values in the combined calibration and verification years 1978 - 1986. The data are exhibited to illustrate monthly performance at different times in the year. The greatest over- and undersimulation appears in April and May, which is expected due to the seasonal snowmelt that can greatly affect stream discharge measurements. April, May, and June show the greatest oversimulation, but excluding outliers, the errors are fairly evenly distributed and not too great. July through February have the least difference between simulated and observed values.

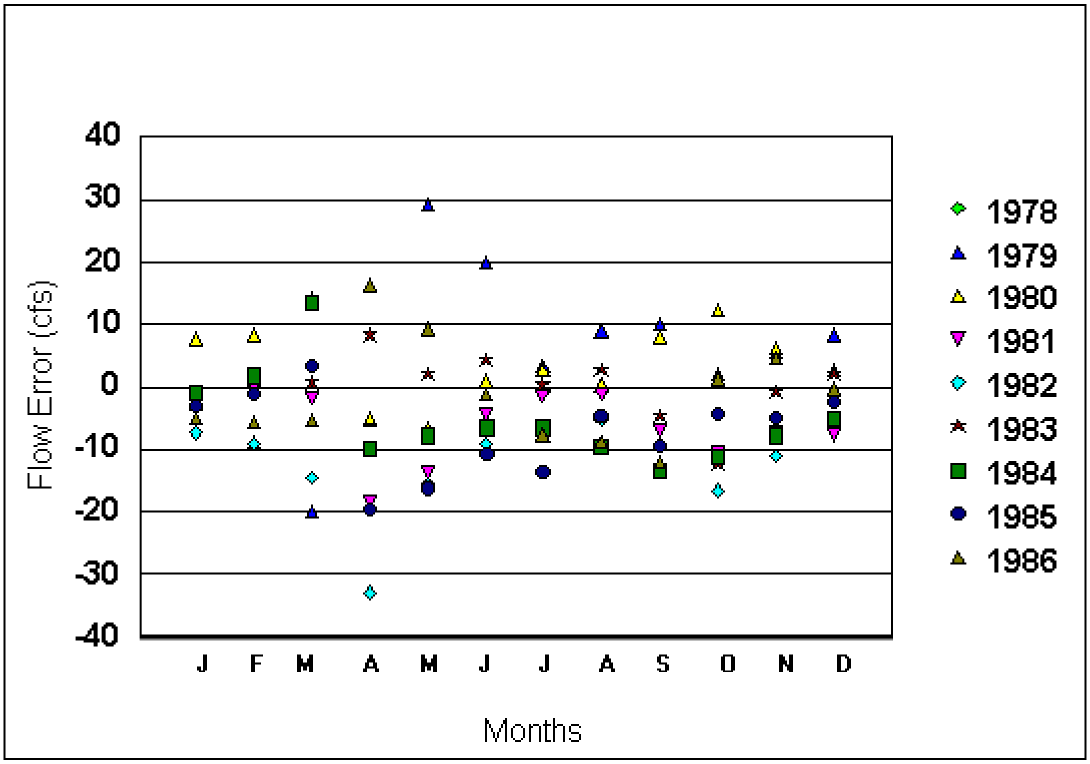


Figure 28. Monthly Error (simulated - observed) for Swamp Creek above Rice Lake, Calibration and Verification years, 1978 - 1986.

DEVELOPMENT OF SWAMP AND PICKEREL CREEKS SCENARIOS

HSPF may be used to analyze scenarios representing changes at the surface. The calibration and verification parameters are used to generate a 41-year baseline of flow corresponding to current, natural conditions. The generated time series incorporates a wide range of measured meteorological input from 1955 through 1995, and encompasses the wet, dry, and average conditions that may then be used as a basis for any future scenario comparisons. In the scenario simulations, HSPF does not simulate actual time series of observable events, rather, HSPF results are used to compare relative differences between baseline and scenario(s), not between absolute values or individual numerical results.

In interpreting the results of these simulations, it is important to remember that the calibration and verification of the Swamp Creek and Pickerel Creek watershed models were based upon nine years of observed data from two streamflow gages within the Swamp Creek basin. While as many physical characteristics of each watershed as possible were used (such as soil porosities, land-surface elevations, etc.), other characteristics for which there are little or no observed data were not incorporated into the watershed models. Simulation results indicate that the calibration and verification are good, especially considering the spatial variability of rainfall, as demonstrated by the broad range of model output that was compared to measured data (streamflow, lake water-surface and groundwater elevations). It is also important to note that watershed models cannot always accurately simulate observed flows and water levels because of data and model deficiencies. However, the inaccuracies due to data deficiencies are much less important in the comparison of scenarios because the same input time-series are used to obtain both the baseline result and the scenario result and the errors in input data effectively cancel each other out in the comparison among baseline and scenarios. Therefore, the relative accuracy of comparing scenarios generally is substantially better than the absolute accuracy of the model to estimate runoff for a selected time period, and the absolute accuracy already has been assessed as good relative to the goals stated in the QAPP.

Sensitivity Analysis

A formal sensitivity analysis often is done as part of modeling studies in an effort to assess the usefulness of the model for decision making and/or the robustness of the conclusions reached from the comparison of baseline and scenario conditions. For example, if under baseline conditions of a natural, unaltered watershed, a wide range of model parameter values results in nearly the same simulated streamflow (an insensitive model), then it is difficult to apply this model to conditions involving an altered watershed because the wide range of model parameters might not be valid for the altered watershed. Conversely, if the model is found to have well identified parameters and the model results are sensitive to the values of these parameters, then the model can be more reliably used for decision making.

In the case of the HSPF model, the sensitivity of the simulated streamflow to the model parameter values was clearly seen during the 1,600 calibration runs and 200 verification runs. The calibration required matching observed flows at two streamflow gages (above and below Rice Lake) as well as limited lake water-surface elevation and wetland water level data in the Swamp Creek watershed. The verification required matching observed flows during a separate time period in the Swamp Creek watershed as well as limited lake water-surface elevation data in the Pickerel Creek watershed. The requirement to obtain good simulation results at two locations for two time periods sharpened the model parameter identification process. As the final model parameter values were approached, a change to any parameter made one resultant calibration criterion better at the expense of another criterion, or one location or period would achieve a better fit at the expense of another. Thus, the final model parameter values offer a balance among acceptable results at each location and for each time period. The typical sensitivity analysis approach of incrementally increasing each parameter value 25, 50, or more percent and then applying a similar decrease in each parameter value would certainly result in the use of parameter values that are not valid for the Swamp and Pickerel Creek watersheds. Thus, sensitivity analysis was not applied to the parameter values.

Assumptions within HSPF

There are some aspects of modeling that could not be adjusted in fine detail because the changes would not add much predictive value to the model. Assumptions to be noted are:

- Temporal: The 41 year baseline, and any future scenario used in comparison, does not model what would happen in any particular year, nor does it predict cumulative impacts. The purpose of using a 41-year input time series is to evaluate changes in flows and water levels over as wide a range of naturally occurring input (precipitation, evapotranspiration, etc.) as reasonably as possible.

- Hydraulic conductivity: HSPF is a surface water model and represents ground water in a very simple way. Therefore, there was no parameter directly comparable to the hydraulic conductivity (permeability) used in groundwater models. One surrogate within HSPF for this property is the seepage restriction applied to water flowing through lake beds. For comparison, the GFLOW analytic element model included “bottom resistance” terms for streams and lakes that were not fully connected to the underlying aquifer (Haitjema and Kelson, 1998). MODFLOW’s LAK2 package also included hydraulic conductivity values that restrict flow through lake beds.

- Elevation: Each land use and water level within each land segment (PERLND), and stream reach (RCHRES) was represented by a single mean elevation, based on USGS digital elevation models, possibly adjusted to agree with measured lake and/or wetland water-surface elevations. As described in the Quality Assurance Project Plan, the base elevation (BELV) was defined as the bottom of the adjacent stream channel, which, lacking more detailed information, was often set at 2.0 ft below the mean elevation (MELEV) of each of the wetlands.

- Soil consolidation: if any potential scenario indicates that dewatering causes wetlands in the area to dry out, the storage parameters (e.g., the porosities and upper and lower zone nominal storage) for these PERLNDs could be modified in an attempt to reflect the changes in water capacity caused by consolidation of the soils. HSPF does not simulate the dewatering-consolidation process.

Pickerel Creek Watershed Concepts

For the Swamp Creek watershed, it was determined that the nature of the lakes and their seepage characteristics did not require special hydrological consideration within the context of the model, based on information in the EIR and other studies. However, for the Pickerel Creek watershed, the model required fine-tuning for seepage. In future scenarios, changes in stream fluxes or other methodologies could be utilized for any new interpretation of groundwater impacts on stream flow.

A major issue that evolved during this project was lake seepage. There must be some restriction of flow through some lake bottoms. The lakes in the Pickerel Creek watershed originated as kettles in a glacial terrain, with fine-grained material from the melting ice block comprising the original lake beds. Every core of these lake beds taken by WDNR confirms this composition of glacial origin (Carlson, 2001, personal communication). A not-insignificant amount of loess may also have settled into these lakes (except much or all of Skunk Lake). Therefore, the naturally occurring substrate limits flow through these lake bottoms into the underlying aquifer.

While the lakebeds have been cored and the materials described, seepage from these lakes is not well characterized. The only available measurements were made by NMC in January 1985, published as Appendix I (Range of Potential Seepage from Little Sand, Oak, Duck, and Skunk Lakes) in NMC (1995, revised 1998) EIR, Appendix 3.6-9. The seepage was computed by means of a mass balance between gains (precipitation, stream inflow) and losses (evaporation, stream outflow) and attributing the remaining difference in lake volume to seepage loss. In addition, NMC (1995, revised 1998) published Estimated Water Balance Components for annual water balances for the four lakes listed above plus Deep Hole Lake (summarized in Table 4.2, page 3.6-9-74). The seepage values are all based on short-term (2-3 weeks) studies (including Deep Hole, though data for Deep Hole Lake are not included in NMC's Appendix I).

The analytical element model (GFLOW, Hunt, 1999) describes the lakes with head-dependent flux boundaries (Hunt, 2001, personal communication). Hunt also noted that in the analytic element model, lakes are a small part of the regional water balance affected by the mine and that since the MODFLOW model looked at lakes in more detail, using the Lake Package (LAK2) (Council, 1999), the MODFLOW results provide more information about lake water balances. The LAK2 package models hydraulic conductance through the lake bed as a linear function of the hydraulic conductivity (K) in each cell, divided by the thickness of the lake bed. Flow through the lake bottom is equal to the conductance multiplied by the difference between the elevation of the lake water surface and the groundwater table in cells which are connected to a lake (Council, 1999, p. 9, Figure 3).

HSPF Seepage Methodology: A detailed analysis by HSPF modelers yielded little consistency for any of the lakes for estimating seepage when comparing 1) water balance results, from measurements published in the NMC EIR, 2) LAK2 package results, calculated by the WDNR (tabulated as GW OUT in the WDNR zinc2a.inl file) converted from ft^3/day to ft^3/sec., and 3) initial HSPF modeling results. Seepage can be highly variable, as illustrated in Table 14 in the four lakes in the Pickerel Creek watershed. When comparing results for Little Sand, Duck, Skunk and Deep Hole Lakes, the seepage computed from the first two columns, water balance versus MODFLOW, did not remain in proportion: in two lakes seepage was higher and in two lakes it was lower from one method relative to the other. The two columns of numbers show only slight consistency: Little Sand Lake always has the highest value and Skunk Lake always has the lowest value; Deep Hole Lake and Duck Lake alternate between the middle values. Ratios between the entries in these two columns vary from less than 1.0 for Duck Lake and Skunk Lake to greater than 3.0 for Deep Hole Lake and Little Sand Lake. In the fitting of HSPF seepage, column three, Duck Lake allows for no seepage, with the greatest amount of seepage coming from Deep Hole Lake. Lowest and highest values are not consistent with results in either of the first two columns. Though the HSPF seepage is closer to the water balance seepage overall, there is nearly a 10-fold difference in Little Sand Lake and Skunk Lake water balance seepage and HSPF seepage.

Table 14. Comparison of the Nicolet Minerals Company (NMC) water balance, Wisconsin Department of Natural Resources (WDNR) MODFLOW, and Hydrological Simulation Program - Fortran (HSPF) seepage estimates in four lakes in the vicinity of the proposed Crandon Mine in Wisconsin

Lake	Water Balance NMC Seepage (cfs)	Background WDNR Seepage (cfs)	Calibrated HSPF Seepage (cfs)
Deep Hole	0.12	0.371	0.12
Duck Lake	0.19	0.065	0
Little Sand	0.22	0.755	0.025
Skunk Lake	0.07	0.044	0.005

This analysis, combined with sparsely measured and short-term seepage values, and the unreliability of measured seepage values (Winter et al., 1998), led to a decision to back-calculate the seepage for each lake individually, using *observed lake level values for each lake* as the endpoint for calculating seepage values. Seepage in each lake was varied (i.e., calibrated) to minimize the difference between the observed and simulated lake levels (see Figures 24, 25(B), 26(B), and 27).

Within the HSPF model, the seepage through the lake bottoms was varied as a function of lake depth by values set in a volume-depth-discharge table (FTABLE) for each lake. Variations in seepage with depth were implemented in HSPF in two ways: 1) as the depth of the lake changes and 2) as the area of the lake bed through which water can seep changes. The seepage is varied linearly with depth: thus, if lake stage is lower than a reference elevation (initial water-surface elevation), seepage is reduced proportionally, and if it is higher, it is increased proportionally. This is an application of Darcy's law using the depth of the water as the head. Similarly, the area of the lake was used as the basis for varying the seepage linearly with lake area. If the area of the lake is less than the basis area (defined as original reference surface area from the Digital Elevation Map), seepage is reduced proportionally and if the area is greater, seepage is increased proportionally. These variations are simplistic but are implemented in this manner due to the absence of data and a more rigorous methodology.

The difference between the WDNR seepage (from the MODFLOW LAK2 module) and the fitted HSPF seepage as shown in Table 14 can be attributed to differences in the computation of the water balance of lakes. The water balance for lakes is:

$$\begin{aligned}\text{Volume in Lake}(i+1) = {} & \text{Volume in Lake}(i) + \text{Precipitation}(i+1) - \text{Evaporation }(i+1) \\ & + \text{Runoff }(i+1) - \text{Seepage }(i+1)\end{aligned}$$

In LAK2, the i are years, precipitation and evaporation are representative annual values (mean, wet year, dry year, etc.), runoff is computed by a constant coefficient applied to the representative annual precipitation, and seepage is computed by Darcy's law applied to the lake bed using the lake and groundwater surface elevations to determine the hydraulic gradient. In HSPF, the i are hours, precipitation and evaporation (calculated) are hourly values determined directly from the 41-year time series of meteorologic input, runoff is simulated on an hourly basis, and the natural seepage is adjusted as a linear function of water-surface elevation and water-surface area (represented in the FTABLEs in HSPF).

Swamp Creek Watershed Results

The baseline is the output form the model using the same parameter values utilized in achieving the water balance for natural conditions in calibration and verification, using observed hydrological data. The locations where model output may be obtained are shown in Figure 29. Additional output locations could be specified by revising the User Control Input (UCI) file in Appendix 3. Those same parameter values were used for a 41-year simulated baseline using observed meteorological data for a period that does not include complete observed hydrological data series. Overall summary statistics for the simulated baseline period are listed in Table 15. The model simulation of storms and storm statistics used observed data selected from storm events (including some possible snowmelt influence in high flows for April) shown in Table 7. The statistical analysis of the 41-year simulation considered 36 storms. A more detailed quantification of the results by segment or by reach better describes values in the 41-year baseline and begins with Table 18.

Lake and Reach Stages in Swamp Creek Watershed
(Swamp WDM, RCHRES and PLS locations, STAGE)

Each section heading, (as shown above Swamp WDM, RCHRES and PLS locations, STAGE), indicates the location within GenScn (Kittle et al., 1998) where the data may be accessed. Stage-duration and flow-duration plots represent all 41years for the baseline unless otherwise stated.

The Swamp Creek watershed results are presented by reaches (RCHRES) which correspond to one or several HSPF segments and one or several land cover areas (Pervious Land Segments, PLS) as listed in Table 16. Segments 10, 70, and 110 are not represented in this table of reaches because they contain no stream segments. Segment 10 is located in the far northwestern portion the basin; segments 70 and 110 include Mole Lake, and Oak Lake, respectively, which have no outlets.

The model segments which contain lakes in the Swamp Creek watershed are 20, 60, 200, and 210, representing Lake Metonga, Rice Lake, Ground Hemlock Lake, and Lake Lucerne, respectively. The lake and stream stages are listed in Table 17. Figure 30 is an example of the Gliske Creek stage duration curve. Similar figures could be generated for any of the locations shown in Figure 29.

Table 15. Summary statistics for the Swamp Creek watershed 41 year baseline simulation

Description	Baseline
Total runoff (in.)	325.9
Total of highest 10% flows (in.)	98.93
Total of lowest 50% flows (in.)	72.58
Evapotranspiration (in.)	928.8
Total storm volume (in.)	16.45
Average of storm peaks (cfs)	181.6
Baseflow recession rate	0.99
Total simulated storm interflow (in.)	67.15
Total simulated storm surface runoff (in.)	43.37
Summer flow volume (in.)	83.59
Winter flow volume (in.)	54.78
Summer storm volume (in.)	4.99

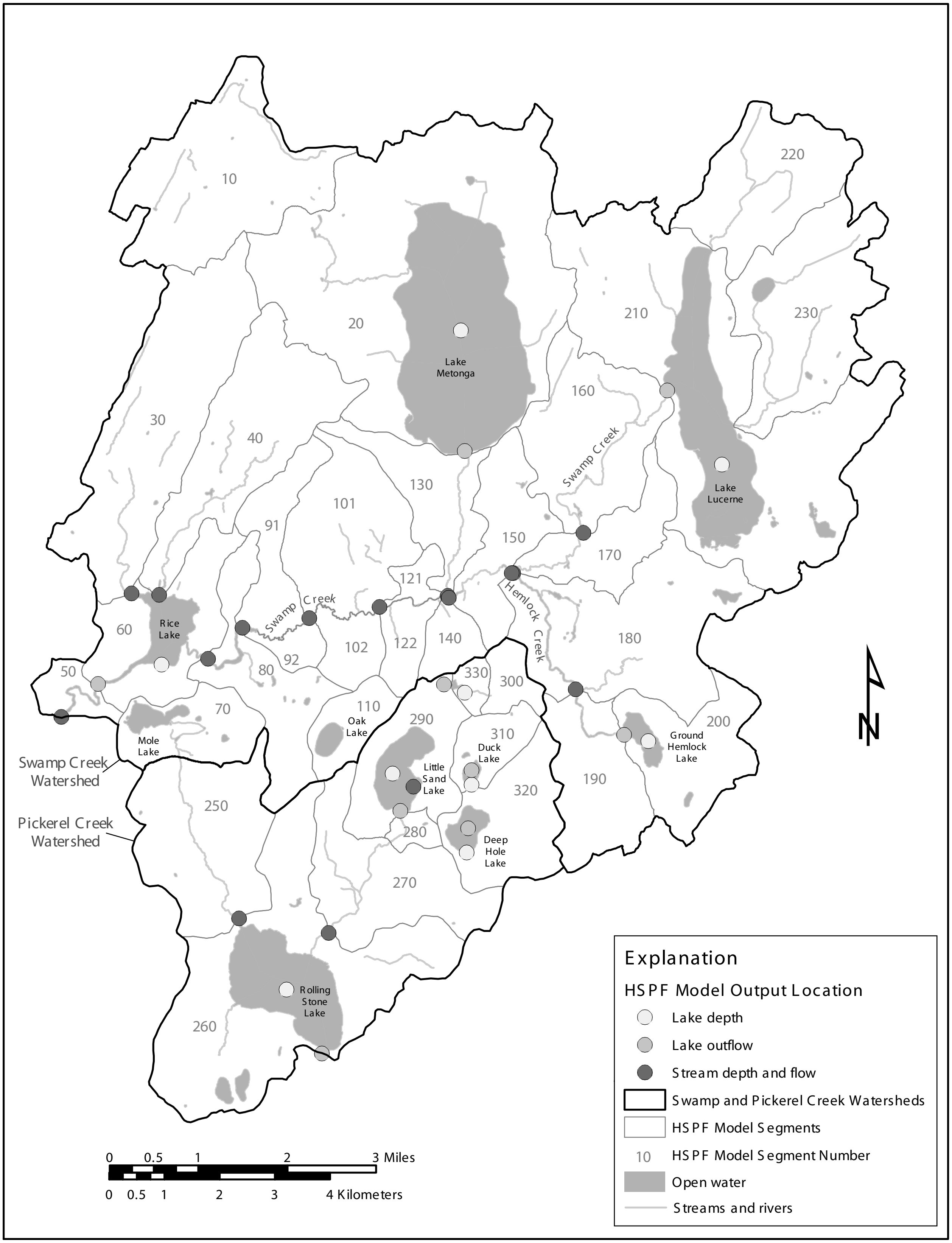


Figure 29. Model output locations used in the comparison of simulation results obtained with the Hydrological Simulation Program - Fortran (HSPF) for baseline and scenario conditions in the vicinity of the proposed Crandon Mine in Wisconsin.

Table 16. Swamp Creek watershed reach (RCHRES), Segment, and Pervious Land Segment (PLS) delineation

RCHRES corresponds with Segment(s) —>>	**Segment corresponds with PLS —>>**	**PLS* (land cover areas)**
20 (lower Metonga)	20	102 202 302 502 602
30 (tributary to Rice Lake)	30	103 203 503 603
40 (Gliske Creek)	40	104 204 504 604
50 (below Rice Lake)	50	105 205 605
60 (Rice Lake)	60	106 206 606
80 (above Rice Lake)	80/ 110	108 208 508 608/ 111 211 511
90 (Lower Swamp Creek)	91/ 92	109 209 509 609/ 139 639
100 (Middle Swamp Creek)	101/ 102	110 210 510 610/ 140 540 640
120 (Upper Swamp Creek)	121/ 122/ 140	112 612/ 142 542 642/ 114 214 514 614
130 (Outlet Creek)	130	113 213 513 613
150 (Swamp Creek at Outlet Creek confluence)	150	115 215 515 615
160 (Swamp Creek below Lake Lucerne)	160	116 216 616
170 (Swamp Creek at Hemlock Creek confluence)	170	117 217 517 617
180 (Lower Hemlock Creek)	180	118 218 518 618
190 (Hemlock Creek below Ground Hemlock Lake)	190	119 219 519 619
200 (Ground Hemlock Lake)	200	120 220 520 620
210 (Lake Lucerne)	210/ 220/ 230	121 221 521/ 122 222 522/ 123 223 523

* Land areas beginning with “1" are forest, “2" are agriculture/pasture, “3" are urban, “5" are recharge wetlands, “6" are discharge wetlands

Table 17. Swamp Creek watershed simulated baseline stages by segment

Segment	Stage Max in feet *	Stage Min in feet *	Stage Mean in feet *
BASELINE			
20 (lower Metonga)	1606.3	1604	1605.1
30 (trib. to Rice Lk.)	4.07	0.15	1.09
40 (Gliske Creek)	1.9	0.03	0.25
50 (below Rice Lk.)	8.71	0.17	1.32
60 (Rice Lake)	1535.3	1532.6	1533.4
80 (above Rice Lake)	8.22	0.17	1.51
90 (Lower Swamp Creek)	5.31	0.11	0.88
100 (Middle Swamp Creek)	5.6	0.11	0.91
120 (Upper Swamp Creek)	3.18	0.06	0.55
130 (Outlet Creek)	2.72	0.03	0.62
150 (Swamp Creek at Outlet Creek)	5.31	0.1	0.9
160 (Swamp Creek below Lake Lucerne)	2.26	0.04	0.43
170 (Swamp Creek at Hemlock Creek)	4.3	0.07	0.79
180 (Lower Hemlock Creek)	4.39	0.1	0.77
190 (Hemlock Creek below Ground Hemlock)	3.08	0.07	0.51
200 (Ground Hemlock Lake)	1579.7	1578.3	1578.7
210 (Lake Lucerne)	1646.2	1644.1	1645.2

* Above segment datum (BELEV) in HSPF

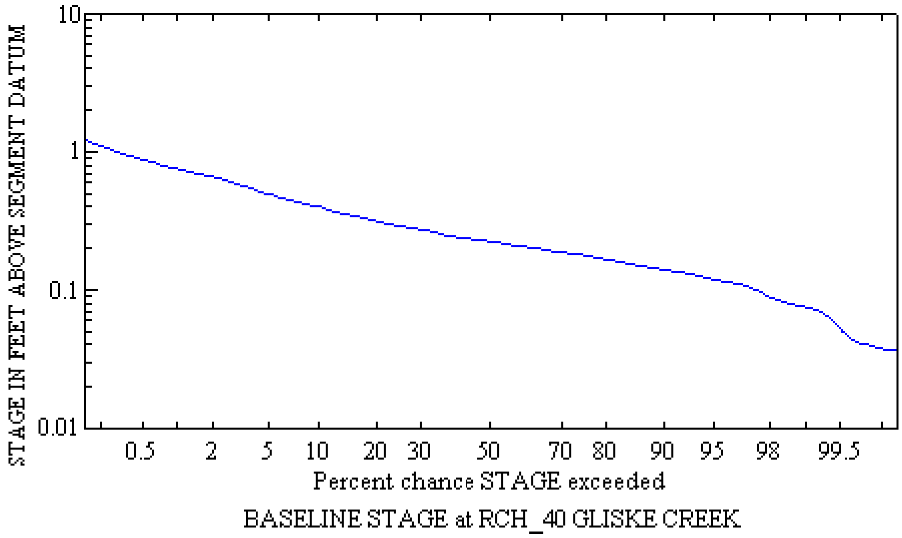


Figure 30. Stage-duration curve for 41-year simulation made with the Hydrological Simulation Program - Fortran for baseline conditions for Gliske Creek.

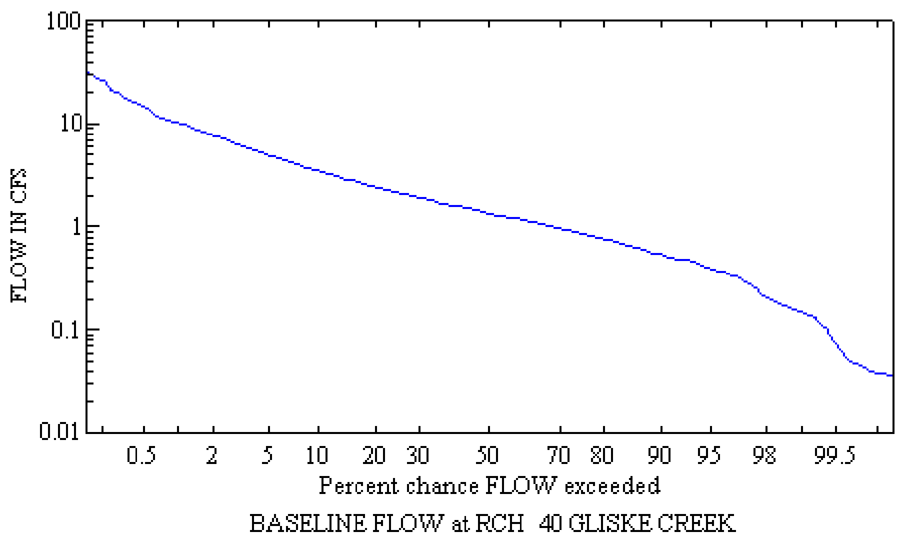


Figure 31. Flow duration curves for 41-year simulation made with the Hydrological Simulation Program - Fortran for baseline conditions for Gliske Creek.

Stream Flows
(Swamp WDM, FLOW)

A baseline flow-duration curve for Gliske Creek in Segment 40 is shown in Figure 31. Maximum, minimum, and mean flows are listed in Table 18.

Table 18. Swamp Creek watershed baseline Flows by segment

Segment	**Flow Maximum in cfs**	**Flow Minimum in cfs**	**Flow Mean in cfs**
Baseline			
20 (lower Metonga)	51.1	0	5.1
30 (trib. to Rice Lk.)	141	0.3	8.9
40 (Gliske Creek)	72.5	0	1.9
50 (below Rice Lk.)	778.3	0.6	37.1
60 (Rice Lake)	756.6	0.6	36
80 (above Rice Lake)	518.4	0.4	24.1
90 (Lower Swamp Creek)	452.7	0.3	22.6
100 (Middle Swamp Creek)	424	0.3	21.7
120 (Upper Swamp Creek)	354.9	0.3	19.8
130 (Outlet Creek)	73.3	0	6.1
150 (Swamp Creek at Outlet Creek)	254.2	0.2	12.5
160 (Swamp Creek below Lake Lucerne)	84.5	0	5.1
170 (Swamp Creek at Hemlock Creek)	110.3	0.1	5.9
180 (Lower Hemlock Creek)	126.6	0.1	5.6
190 (Hemlock Creek below Ground Hemlock)	53.3	0	2.4
200 (Ground Hemlock Lake)	17.2	0	0.9
210 (Lake Lucerne)	30.3	0	3.5

Wetlands
(Swampgwel WDM, PLS location, GWEL)

Table 19 lists a summary of modeled wetlands segment baseline results. All segments are included, whereas in the previous draft only segments within the capture zone showed a change and were the only ones listed in this table. The simulated baseline time series of simulated wetland water-surface elevations for segment 140 (Upper Swamp Creek) is shown in Figure 32 as an example of the wetland output from the HSPF model developed in this study.

Table 19. Groundwater Elevation (GWEL) in the Swamp Creek watershed Recharge and Discharge Wetlands baseline

Wetland	Max. elev. in feet	Min. elev. in feet	Mean elev. in feet	Wetland	Max. elev. in feet	Min. elev. in feet	Mean elev. in feet
PLS	**Baseline**	**Baseline**	**Baseline**	**PLS**	**Baseline**	**Baseline**	**Baseline**
501 Recharge Seg. 10	1746.3	1743.9	1744.7	602 Discharge Seg 20	1626.5	1624.1	1625
502 Recharge Seg. 20	1626.2	1624	1624.7	603 Discharge Seg 30	1569.5	1567	1568
503 Recharge Seg. 30	1569.3	1566.9	1567.8	604 Discharge Seg 40	1551.2	1548.9	1549.8
504 Recharge Seg. 40	1604.5	1602	1603.1	605 Discharge Seg 50	1539.5	1537	1538.1
507 Recharge Seg. 70	1571.7	1569.2	1570.7	606 Discharge Seg 60	1535.1	1532.9	1533.6
508 Recharge Seg. 80	1604.5	1602.1	1603.2	607 Discharge Seg 70	1557.2	1554.9	1555.8
509 Recharge Seg. 90	1593.2	1590.9	1591.7	608 Discharge Seg 80	1538.2	1535.9	1536.7
510 Recharge Seg. 100	1596.5	1594.1	1595.1	609 Discharge Seg 90	1538.2	1535.9	1536.7
511 Recharge Seg. 110	1638.7	1636.2	1637.4	610 Recharge Seg 100	1553.2	1550.8	1551.7
513 Recharge Seg. 130	1595.3	1592.9	1593.9	612 Recharge Seg 120	1567.2	1564.9	1565.7
514 Recharge Seg 140	1627.4	1625	1625.9	613 Recharge Seg 130	1584.1	1581.7	1582.5
515 Recharge Seg 150	1593.1	1590.8	1591.5	614 Recharge Seg 140	1586.4	1584	1584.9
517 Recharge Seg 170	1586.6	1584.1	1585.4	615 Recharge Seg 150	1593.2	1590.9	1591.7
518 Recharge Seg 180	1591.4	1589	1589.9	616 Discharge Seg 160	1606.4	1604	1604.9
519 Recharge Seg 190	1650.6	1648.1	1649.2	617 Discharge Seg 170	1580.3	1577.9	1578.8
520 Recharge Seg 200	1605.6	1603.1	1604.3	618 Discharge Seg 180	1595.3	1592.9	1593.8
521 Recharge Seg 210	1657.8	1655.2	1656.6	619 Discharge Seg 190	1588.2	1585.8	1586.6
522 Recharge Seg 220	1672.8	1669.8	1670.7	620 Discharge Seg 200	1597.6	1595.1	1596.4
523 Recharge Seg 230	1713.4	1710.7	1711.5	639 Discharge Seg 390	1538.2	1535.9	1536.7
540 Recharge Seg 102	1597	1594.4	1596.1	640 Discharge Seg 640	1553.4	1551	1551.9
542 Recharge Seg 122	1624.7	1622.2	1623.5	642 Discharge Seg 642	1567.3	1565	1565.8

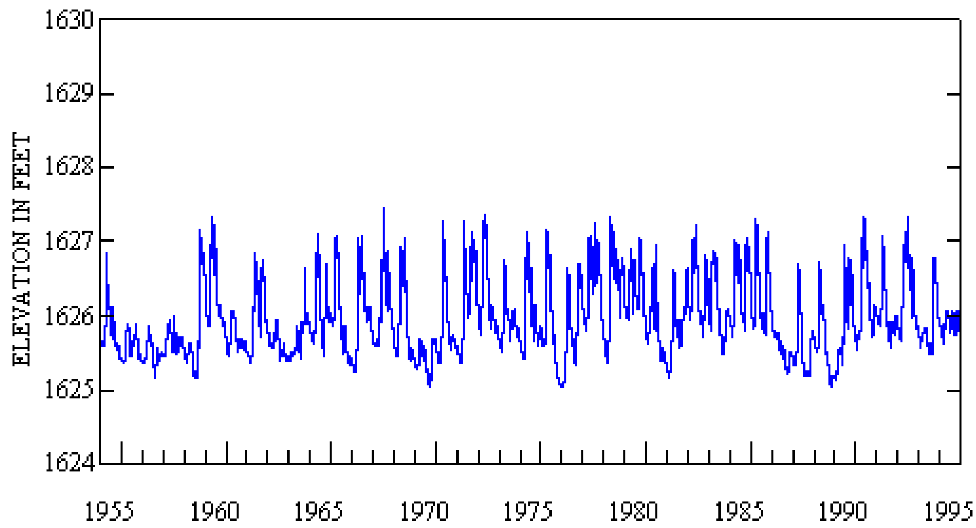


Figure 32. Wetland water-surface elevation computed with the Hydrological Simulation Program-Fortran for a hypothetical 41-year period (driven by 1955 - 1995 data) for baseline conditions for segment 140 Upper Swamp Creek (Pervious Land Segment (PLS) 514).

Pickerel Creek Watershed Results

The Pickerel Creek baseline, was computed using the calibrated Swamp Creek HSPF parameters, adjusted to include the seepage calibrations previously described (*i.e*. through the process of back-calculation of seepage to observed lake water-surface elevation values). In the baseline runs, lake water-surface elevations, stream flow, and lake outlet flows are included in the available Pickerel Creek watershed model outputs.

Lake Stage in the Pickerel Creek Watershed
(Pick_out.wdm, Lakes Location, STAGE or SEEPAGE)

Table 20 lists the pervious land segments (PLS) and the corresponding subwatershed segments where the PLS's are located within the Pickerel Creek watershed. Table 21 lists the maximum, minimum, and mean lake water-surface elevation for the simulated 41-year baseline. Figure 33 shows the simulated flow duration curve for the Little Sand Lake inlet for the 41-year baseline.

Stream and Lake Outlet Flows
(Pick_out.wdm, Streams or Lakes location, FLOW)

Table 22 lists the baseline values of daily streamflows in cubic feet per second. Changes in the flow in drought periods for consideration of stress conditions during shorter time intervals may also be simulated by this model. Table 23 lists the lake outflow from the outlets of the five lakes representing the 41-year evaluation.

Table 20. Pickerel Creek watershed reaches (RCHRES), Segment, and Pervious Land Segment (PLS) delineation in the Hydrological Simulation Program - Fortran

Segment corresponds to ----->>>>>perlnd	**perlnd**
250 (Upper Pickerel Creek)	525 625
260 (Rolling Stone Lake)	526 626
270 (Lower Creek 12-9)	127 527 627
280 (Upper Creek 12-9)	528
290 (Little Sand Lake)	129 529 629
300 (Bur Oak Swamp)	130 530
310 (Duck Lake)	131 531
320 (Deep Hole)	132 532
330 (Skunk Lake)	133 233

Table 21. Pickerel Creek watershed maximum, minimum, and mean lake water-surface elevations in feet for 41 years under simulated baseline conditions.

Lake	**Maximum baseline (ft)**	**Minimum baseline (ft)**	**Mean baseline (ft)**
Rolling Stone	1535.7	1534.7	1535.1
Little Sand	1593.9	1590.9	1592.1
Duck Lake	1613.3	1610.6	1611.7
Deep Hole	1607	1604.2	1605.7
Skunk Lake	1599.8	1596.1	1597.7

Table 22. Maximum, minimum, and mean streamflow in cfs for the Pickerel Creek watershed simulated with the Hydrological Simulation Program - Fortran for the baseline conditions for the full 41-year trial period.

Streams	**Maximum baseline (cfs)**	**Minimum baseline (cfs)**	**Mean baseline (cfs)**
PICKEREL CREEK	36.4	0	1.4
CREEK 12-9	69.9	0.1	2.5
LITTLE SAND INLET	16.8	0	0.5

Table 23. Maximum, minimum, and mean lake outlet outflow in cfs for the Pickerel Creek watershed simulated with the Hydrological Simulation Program - Fortran for the baseline conditions for the full 41-year trial period.

Lake Flow	**Maximum baseline (cfs)**	**Minimum baseline (cfs)**	**Mean baseline (cfs)**
ROLLING STONE	113	0	6.9
LITTLE SAND	19.2	0	1.2
DUCK LAKE	3.7	0	0.1
DEEP HOLE	13.8	0	0.4
SKUNK LAKE	0.8	0	0.01

Wetlands
(Pick_out.wdm, PERLNDS, GWEL)

Groundwater elevation results are calculated in pervious land segments which represent wetlands and where groundwater elevation data from wells are available.

Table 24. Pickerel Creek watershed 1955-1995 groundwater elevations in wetland PERLNDS for baseline conditions.

Pervious Land Segment	**Max. baseline (cfs)**	**Min. baseline (cfs)**	**Mean baseline (cfs)**
PER 525 Upper Pickerel Ck. Recharge Wetland	1596.6	1594.1	1595.2
PER 526 Rolling Stone Lake Weir Recharge Wetland	1644.7	1642.2	1643.4
PER 527 L.Creek 12-9 Recharge Wetland	1629.5	1627	1628
PER 528 Recharge Wetland	1603.1	1600.9	1601.6
PER529 Little Sand Lake	1602.3	1600	1600.7
PER530 Bur Oak Swamp	1645.4	1643	1644
PER531 Duck Lake	1621.5	1618.9	1619.8
PER532 Deep Hole Lake	1647.5	1645	1645.9
PER 533 Skunk Lake	1608.5	1605.6	1606.6
PER625 Upper Pickerel Creek Discharge Wetland	1550.2	1547.9	1548.6
PER626 Rolling Stone Lake Weir Discharge Wetland	1547.2	1544.9	1545.6
PER627 L. Creek 12-9 Discharge Wetland	1553.4	1551.7	1552.7

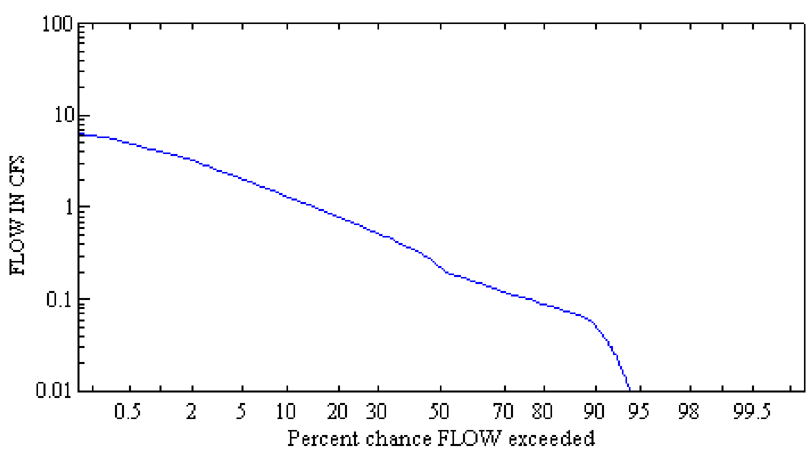


Figure 33. Flow-duration curve for the daily flows simulated with the Hydrological Simulation Program - Fortran for baseline conditions at Little Sand Lake Inlet for meteorological conditions corresponding to 1955 - 1995.

LINKING SCENARIO RESULTS TO BIOLOGICAL ASSESSMENT

One important use of this project's HSPF model would be to analyze the results for assessing the possible effects of surface water changes on the biota and ecological communities. Toward this goal, typical results from HSPF with respect to time series and duration curves of flows and stream, lake, and wetland water-surface elevations have been illustrated in the preceding sections for a 41-year baseline simulation corresponding to current, natural conditions. These baseline conditions may then be altered within the model as they reflect changes to the hydrology of the natural system to help predict changes in species, such as wild rice, or habitat and communities. Average, high, and low flows and stages, percentage exceedences, and stream flow duration curves may be compared. The Swamp and Pickerel Creek watershed data compilations are attached with this report in a CD format.

SUMMARY AND CONCLUSIONS

The Hydrological Simulation Program - FORTRAN (HSPF) model Version 12 was calibrated using streamflow data collected from 1982-1986 at two locations on Swamp Creek above and below Rice Lake, yielding a correlation coefficient of 0.8773 above Rice Lake and 0.8308 below Rice Lake, and a coefficient of model fit efficiency of 0.6803 above Rice Lake and 0.5393 below Rice Lake for monthly flows. The overall water balance was achieved with - 6.8% and 2.6% error above and below Rice Lake, respectively, when comparing simulation to observed. All of the comparison criteria remained well within the targets except where the storm volume error criterion, which was missed by -4.5% above Rice Lake, and low flow recession criterion, which was missed by -0.01 below Rice Lake. Temporal verification used data from 1978-1981, and spatial verification was provided by simulation of lake water-surface elevations in the adjacent Pickerel Creek watershed. For monthly flows, the correlation coefficient for verification was 0.8124 above Rice Lake and 0.8222 below Rice Lake, and a coefficient of model fit efficiency was 0.5218 above Rice Lake and 0.5266 below Rice Lake. All of the comparison criteria remained well within the targets except the low flow recession criterion, which was missed by -0.01 above and below Rice Lake. A simulated baseline representing natural conditions was established using a 41-year continuous time-series of meteorological data corresponding to 1955 - 1995. Using the model, the impact in the ecosystem of any fluctuations or decreases in values in any of the water-surface elevations, lake or stream flows, or wetland levels may be determined by bioassessors and/or ecologists.

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Appendix 1
Soils in HSPF Segments

Appendix 1. Descriptions for Soil Texture Codes (NRCS-SSURGO)

Texture Codes	Texture Description (Original SSURGO categories)
Loam	Loam
Loamy sand/Sandy loam	Aggregated Loamy sand and sandy loam
Muck/Peat	Aggregated Muck and Peat
Silt Loam	Silt Loam
Variable	Aggregated Variable Texture and Unweathered Bedrock
Water	Aggregated Water and Miscellaneous Water

Table 5. Soil Texture (NRCS-SSURGO) for HSPF Segments by WISCLAND Land Cover Type for Forest County (Acres)

	Agriculture	**Agriculture**	**Agriculture**	**Agriculture**	**Agriculture**	**Agriculture**	**Barren**	**Barren**	**Barren**	**Barren**	**Barren**	**Barren**	**Discharge Wetland**	**Discharge Wetland**	**Discharge Wetland**
Segment	Loam	Loamy Sand & Sandy Loam	Muck & Peat	Silt_Loam	Aggreg. Variable Texture & Unweathered Bedrock	Aggreg. Water & Misc. Water	Loam	Loamy Sand & Sandy Loam	Muck & Peat	Silt_Loam	Aggreg. Variable Texture & Unweathered Bedrock	Aggreg. Water & Misc. Water	Loam	Loamy Sand & Sandy Loam	Muck & Peat
10	0.00	17.66	29.02	228.76	5.08	0.29	0.00	2.90	8.86	24.42	6.42	0.45	0.00	0.00	0.00
20	0.00	17.57	27.17	633.81	6.20	1.20	0.00	15.66	19.76	97.05	15.49	10.18	0.05	3.36	96.76
30	0.00	5.04	7.69	118.27	0.00	0.00	0.00	0.00	0.00	2.15	0.00	0.00	0.00	31.73	189.87
40	0.00	14.29	6.68	134.83	0.00	0.00	0.00	0.74	0.90	56.17	0.00	0.00	0.00	52.14	231.01
50	0.00	15.88	0.13	0.00	0.00	0.32	0.00	13.18	0.00	0.00	0.00	0.00	0.00	19.16	30.44
60	0.00	146.78	0.69	9.34	0.00	0.23	0.00	54.63	0.26	0.00	0.00	0.00	0.00	38.39	362.91
70	0.00	95.29	2.69	0.00	0.00	0.04	0.00	21.17	0.15	0.00	0.00	0.24	0.00	30.97	139.06
80	0.00	94.81	0.83	48.24	0.00	0.00	0.00	28.94	0.11	19.62	0.00	0.03	0.00	12.58	87.37
90	0.00	33.32	1.04	155.56	0.00	0.00	0.00	4.55	0.03	32.04	0.00	0.00	0.00	6.39	177.94
100	0.00	4.25	4.30	222.40	0.00	0.00	0.00	0.00	0.00	9.37	0.00	0.00	0.00	33.90	223.40
110	0.00	0.59	1.14	3.29	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
120	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.86	61.84
130	0.00	2.32	0.67	174.98	0.00	0.00	0.00	0.64	0.00	9.20	0.00	0.00	4.15	9.78	100.94
140	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	73.92
150	0.00	109.29	13.23	43.30	0.00	0.00	0.00	0.28	0.00	0.55	0.00	0.00	0.00	17.92	124.00
160	0.00	31.81	2.39	6.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72.33	214.84
170	0.00	43.47	0.21	28.47	0.00	0.00	0.00	0.00	0.00	5.26	0.00	0.00	0.00	25.22	102.96
180	0.00	48.43	2.06	26.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.32	296.18
190	0.00	0.00	0.00	7.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.17	184.01
200	0.00	59.81	3.70	3.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.15	21.66
210	0.00	18.09	1.58	158.73	0.00	2.60	0.00	1.63	0.00	4.60	0.19	0.53	0.00	0.00	0.00
220	0.00	0.00	0.96	66.79	0.00	0.00	0.00	0.00	0.00	2.87	0.00	0.00	0.00	0.00	0.00
230	0.00	0.00	0.28	71.86	0.00	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	No data														
260	No data														
270	No data														
280	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
290	No data														
300	0.00	0.00	0.03	2.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
310	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
320	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
330	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5. Soil Texture (NRCS-SSURGO) for HSPF Segments by WISCLAND Land Cover Type for Forest County (Acres)

Segment	Discharge Wetland Silt_Loam	Discharge Wetland Aggreg. Variable Texture & Unweathered Bedrock	Discharge Wetland Aggreg. Water & Misc. Water	Forest Loam	Forest Loamy Sand & Sandy Loam	Forest Muck & Peat	Forest Silt_Loam	Forest Aggreg. Variable Texture & Unweathered Bedrock	Forest Aggreg. Water & Misc. Water	Recharge Wetland Loam	Recharge Wetland Loamy Sand & Sandy Loam	Recharge Wetland Muck & Peat	Recharge Wetland Silt_Loam	Recharge Wetland Aggreg. Variable Texture & Unweathered Bedrock	Recharge Wetland Aggreg. Water & Misc. Water
10	0.00	0.00	0.00	0	43.93	246.36	1272.34	0.25	0.00	0.00	11.18	170.19	40.00	0.00	0.00
20	13.11	0.05	3.83	1.69	120.27	171.76	2083.45	10.65	34.40	0.00	5.01	179.08	35.44	0.04	0.00
30	43.16	0.00	0.00	0	204.51	100.68	1784.95	0.00	0.00	0.00	0.23	0.03	4.53	0.00	0.00
40	10.13	0.00	1.93	0	240.83	55.00	947.18	0.00	0.00	0.00	0.00	55.56	15.24	0.00	0.00
50	0.00	0.00	2.95	0	156.66	8.55	2.93	0.00	6.99	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	9.22	0	340.77	23.84	49.30	0.00	2.18	0.00	0.00	0.00	0.00	0.00	0.00
70	0.00	0.00	3.91	0	312.11	10.26	22.20	0.00	6.82	0.00	1.45	1.90	0.00	0.00	0.00
80	0.00	0.00	15.48	0	307.13	16.57	344.21	0.00	0.31	0.00	7.53	33.93	38.58	0.00	1.98
90	0.59	0.00	2.59	0.00	112.56	15.00	306.93	0.00	0.00	0.00	0.00	0.00	2.39	0.00	0.00
100	0.82	0.00	0.00	0.00	256.80	61.63	777.42	0.00	0.00	0.00	4.97	82.21	43.13	0.00	0.00
110	0.00	0.00	0.00	0.00	82.71	9.21	238.18	0.00	3.92	0.00	4.21	21.80	8.64	0.00	2.17
120	4.89	0.00	0.00	0.00	57.60	35.13	278.88	0.00	0.00	0.00	0.00	13.95	4.23	0.00	0.00
130	5.44	0.00	0.00	4.17	46.48	31.14	394.35	0.00	0.58	0.00	0.00	15.96	40.21	0.00	0.49
140	11.19	0.00	0.00	0.00	20.78	2.57	168.86	0.00	0.00	0.00	0.31	0.00	3.04	0.00	0.00
150	2.73	0.00	0.00	0.00	92.59	28.69	176.90	0.00	0.00	0.00	10.09	157.30	78.34	0.00	1.40
160	70.39	0.00	3.77	0.00	25.87	59.59	1063.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
170	25.81	0.00	0.00	0.00	94.01	6.35	396.55	4.86	0.00	0.00	3.89	11.00	1.72	0.00	0.00
180	14.44	0.00	3.80	0.00	675.18	49.72	846.58	0.00	0.00	0.00	15.64	89.37	12.09	0.00	0.00
190	25.86	0.00	2.42	0.00	95.27	23.39	621.17	0.00	0.00	0.00	0.69	30.46	19.98	0.00	0.00
200	4.03	0.00	1.06	0.00	316.26	28.47	534.38	0.00	9.43	0.00	9.42	8.25	4.81	0.00	0.00
210	0.00	0.00	0.00	0.00	308.87	32.25	3039.86	9.56	61.97	0.00	25.20	72.83	32.57	0.00	8.30
220	0.00	0.00	0.00	0.00	0.00	44.95	1225.62	0.00	0.00	0.00	0.00	31.00	10.61	0.00	0.00
230	0.00	0.00	0.00	0.00	4.70	43.44	1528.34	0.00	4.51	0.00	0.00	151.00	33.89	0.00	2.61
250															
260															
270															
280	0.00	0.00	0.00	0.00	5.96	10.41	75.44	0.00	0.00	0.00	0.00	31.18	7.38	0.00	0.00
290															
300	0.00	0.00	0.00	0.00	0.00	2.40	196.52	0.00	0.00	0.00	0.00	30.52	20.41	0.00	0.00
310	0.00	0.00	0.00	0.00	0.00	4.18	285.45	0.00	1.50	0.00	0.00	54.34	14.93	0.00	3.47
320	0.00	0.00	0.00	0.00	0.00	9.67	788.16	0.00	7.34	0.00	0.00	75.18	62.43	0.00	1.65
330	0.00	0.00	0.00	0.00	11.88	3.31	97.31	0.00	0.62	0.00	0.07	3.35	5.74	0.00	0.00

Table 5. Soil Texture (NRCS-SSURGO) for HSPF Segments by WISCLAND Land Cover Type for Forest County (Acres)

	Shrubland	**Shrubland**	**Shrubland**	**Shrubland**	**Shrubland**	**Shrubland**	**Urban**	**Urban**	**Urban**	**Urban**	**Urban**	**Urban**	**Water**	**Water**	**Water**	**Water**
Segment	Loam	Loamy Sand & Sandy Loam	Muck & Peat	Silt_Loam	Aggreg. Variable Texture & Unweathered Bedrock	Aggreg. Water & Misc. Water	Loam	Loamy Sand & Sandy Loam	Muck & Peat	Silt_Loam	Aggreg. Variable Texture & Unweathered Bedrock	Aggreg. Water & Misc. Water	Loam	Loamy Sand & Sandy Loam	Muck & Peat	Silt_Loam
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	15.57	0.03
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	33.67	455.07	0.00	4.67	0.38	3.53	6.99	8.23
30	0.00	0.83	0.00	7.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	11.58	1.20
40	0.00	2.31	1.03	1.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.00
50	0.00	12.41	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	1.07	0.00
60	0.00	3.71	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	9.72	0.00
70	0.00	5.88	3.21	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.22	0.39	0.00
80	0.00	2.80	0.58	1.12	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.02	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	0.00	6.62	1.97	4.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.54	0.85	3.83
110	0.00	1.02	0.51	0.40	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.89	0.20
120	0.00	1.15	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
130	0.00	3.95	2.46	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.37	0.07
140	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
150	0.00	7.57	3.31	7.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.15	0.69
160	0.00	1.98	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.26	0.12
170	0.00	9.13	1.75	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.09	0.34	0.00
180	0.00	19.57	15.64	2.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09	10.68	1.47
190	0.00	0.94	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	1.20
200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.70	0.44
210	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.80	0.33	19.21
220	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
230	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	1.71
250																
260																
270																
280	0.00	0.00	0.11	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91	0.05
290																
300	0.00	0.00	0.48	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
310	0.00	0.00	1.44	2.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.02
320	0.00	0.00	0.28	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	2.12
330	0.00	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	4.52	1.00

Table 5. Soil Texture (NRCS-SSURGO) for HSPF Segments by WISCLAND Land Cover Type for Forest County (Acres)

	Water	Water	Sum of Acres	
Segment	Aggreg. Variable Texture & Unweathered Bedrock	Aggreg. Water & Misc. Water		
10	0.00	0.00	2124.14	
20	0.00	2000.49	6117.54	
30	0.00	0.00	2513.64	
40	0.00	0.12	1828.96	
50	0.00	0.16	271.04	
60	0.00	205.42	1258.71	
70	0.00	68.89	729.09	
80	0.00	0.00	1063.28	
90	0.00	0.00	850.93	
100	0.00	0.00	1744.00	
110	0.00	45.49	425.60	
120	0.00	0.00	474.77	
130	0.00	0.00	849.42	
140	0.00	0.00	281.06	
150	0.00	0.00	875.84	
160	0.00	0.00	1572.39	
170	0.00	0.00	763.57	
180	0.00	0.00	2189.62	
190	0.00	0.00	1055.19	
200	0.00	79.32	1110.58	
210	0.00	990.25	4810.95	
220	0.00	0.00	1382.80	
230	0.00	24.35	1868.33	
250				
260				
270				
280	0.00	0.00	131.57	
290				
300	0.00	0.00	253.20	
310	0.00	22.67	391.46	
320	0.00	91.64	1040.33	
330	0.00	1.74	131.80	

Appendix 2
Soils Types and Properties in Forest County

Appendix 2. Common soil types and (or) soil/urban complexes in Forest County and their properties.

Forest County Soil code	Soil name	SCS Soil Type	Permeability in./hr	Available water capacity	Drainage	Highest water table depth¹ (ft)	Organic matter content & percent
2	Fordum Loam	D	0.6-2.0	0.17-0.24	Poorly -very poorly	+1 to -1	hydric 4-12
17	Capitola Muck	B/D	2.-6.	0.35-0.45	Poorly -very poorly	+1 to -1	Hydric 50-80
18B	Mudlake Silt Loam	C	0.6-2.0	0.18-0.24	Somewhat poorly	0.5-2.0	Hydric inclusions 2-4
19B	Wabeno-Mudlake Silt Loam	B	0.6-2.0	0.14-0.23	Moderately well drained	1.5-3.0	Hydric inclusions 1-3
19D	Soperton-Mudlake Silt Loam	B	0.6-2.0	0.16-0.23	Well drained	>6.0	Hydric inclusions 2-3
20B	Wabeno-Goodwit Silt Loams	B	0.6-2.0	0.14-0.23	Moderately well drained	1.5-3.0	1-3
20C	Wabeno-Goodman Silt Loams	B	0.6-2.0	0.14-0.23	Moderately well drained	1.5-3.0	1-3
20D	Soperton-Goodman Silt Loams	B	0.6-2.0	0.16-0.23	Well drained	>6.0	2-3
22B	Argonne-Sarwet Sandy Loams	B	0.6-2.0	0.14-0.18	Moderately well drained	1.5-3.5	0.5-2.0
22C-D	Laona-Sarona Sandy Loams	B	0.6-2.0	0.14-0.18	Well drained	>6.0	2-3
23D	Metonga-Rock Outcrop Complex	C	0.6-2.0	0.16-0.22	Well drained	>6.0	1-4
26E	Pelissier Gravelly Sandy Loam	A	0.2-6.0	0.1-.12	Excessively drained	>6.0	0.5-1.0
27	Minocqua Muck	B/D²	2.-6.	0.35-0.45	Very poorly drained	+1 to -1	Hydric 60-90
30D	Rubicon Loamy Sand	A	6.0-20.0	0.1-0.12	Excessively drained	>6.0	0.5-2.0
51B	Padus-Wabeno Silt Loams	B	0.6-2.0	0.16-0.24	Well drained	>6.0	2.-4.
51C	Padus-Wabeno Silt Loams	B	0.6-2.0	0.16-0.24	Well drained	>6.0	Hydric inclusions ii2.-4.

Appendix 2. Common soil types and (or) soil/urban complexes in Forest County and their properties (con't)							
Forest County Soil code	**Soil name**	**SCS Soil Type**	**Permeability in./hr**	**Available water capacity**	**Drainage**	**Highest water table depth¹ (ft)**	**Organic matter content & percent**
51D	Padus-Soperton	B	0.6-2.0	0.16-0.24	Well drained	>6.0	Hydric inclusions 2.-4.
100B-C-D	Stambaugh Silt Loam	B	0.6-2.0	0.21-0.24	Well drained	>6.0	1-3
103A	Whislake Silt Loam	C	0.6-2.0	0.16-0.24	Somewhat poorly drained	.5-1.5	Hydric inclusions 1-3
Forest County Soil code	Soil name	SCS Soil Type	Permeability in/hr	Available water capacity	Drainage	Highest water table depth¹ (ft)	Organic matter content & percent
103X	Wormet Sandy Loam	B	0.6-2.0	0.1-0.18	Somewhat poorly drained	.5-1.5	Hydric inclusions 1-3
105B-C-D	Padus Sandy Loam	B	0.6-2.0	0.1-0.18	Well drained	>6.0	1-3
106B-C-D	Padus-Pence Sandy Loams	B	0.6-2.0	0.1-0.18	Well drained	>6.0	1-3
107B-C-D	Pence-Vilas Complex	B	2.0-6.0	0.1-0.18	Well drained	>6.0	1-3
109B	Vanzile Silt Loam	B	0.6-2.0	.21-.24	Moderately well drained	2.5-5.0	1-3
111B-C-D	Pence Sandy Loam	B	2.0-6.0	0.1-0.18	Well drained	>6.0	1-3
113A	Manitowish Sandy Loam	B	2.0-6.0	0.11-0.18	ModeratelyWell drained	3.0-6.0	1-3
115B-C	Vilas Loamy Sand	A	6.0-20.0	.09-0.12	Excessively drained	>6.0	0.5-1.0
117A	Tipler Sandy Loam	B	0.6-2.0	0.1-0.15	Moderately well drained	2.5-3.5	2-3
117X	Padwood Sandy Loam	B	0.6-2.0	0.1-0.18	Moderately well drained	2.5-3.5	2-3
124	Kinross Muck	A/D³	2.-20	0.35-0.45	Poorly drained	+1 to -1	hydric 20-70
126A	Au Gres Loamy Sand	B	6.-20	0.07-0.09	Somewhat poorly drained	0.5-1.5	hydric inclusions 2-4
126X	Flink Loamy Sand	B	2.-6.	0.1-0.12	Somewhat Poorly drained	1.0-2.0	hydric inclusions 1-2

Appendix 2. Common soil types and (or) soil/urban complexes in Forest County and their properties (con't)							
Forest County Soil code	**Soil name**	**SCS Soil Type**	**Permeability in./hr**	**Available water capacity**	**Drainage**	**Highest water table depth[1] (ft)**	**Organic matter content & percent**
127B	Croswell Loamy Sand	A	6.-20	2.0-4.0	Moderately well drained	2.0-4.0	hydric inclusions .5-2
127X	Cublake Loamy Sand	A	2.-6.	0.08-0.12	Moderately well drained	2.5-3.5	1-2
150B	Fence Silt Loam	B	.6-2.	0.22-0.24	Moderately well drained	2.0-6.0	1-2
151A	Gaastra Silt Loam	C	.6-2.	0.20-0.24	Somewhat poorly drained	1.0-2.0	hydric inclusions 3-4
403A	Worcester Sandy Loam	C	.6-2.	0.1-0.18	Somewhat poorly drained	0.5-2.0	hydric inclusions 1-3
707	Lupton, Cathro & MarkeyMucks	A/D[3]	.2-6.	0.35-0.45	Very poorly drained	+1 to -1	hydric 70-90
714	Loxley, Beseman, & Dawson Peats	A/D[3]	6.-20.	0.35-0.65	Very poorly drained	+1 to -1	hydric 70-90

[1] Distance below ground surface is positive
[2] B/D means the soil is type B with tile drainage and type D without.
[3] A/D means the soil is type A with tile drainage and type D without.

Appendix 3
Revision
Swamp Creek Baseline User Controlled Input (UCI) file
Pickerel Creek Baseline UCI file

```
RUN

GLOBAL
  Swamp Creek - Calibration Run with modified groundwatershed - 6/03
*** 41 Year full simulation
  START       1955  1  1  0  0  END    1995 12 31 24  0
*** 1978 - 1986 calib & verif period for plot
  START       1978  1  1  0  0  END    1986 12 31 24  0  ***
*** Verification above & below Rice Lake
  START       1978  1  1  0  0  END    1981 12 31 24  0  ***
*** Calibration above Rice Lake
  START       1982  1  1  0  0  END    1986 12 31 24  0  ***
*** Calibration below Rice Lake
  START       1982  1  1  0  0  END    1985  9 30 24  0  ***
  RUN INTERP OUTPUT LEVEL    4    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<type>  <fun>***<------------fname--------------------------------------------->
WDM1       41   swamp.wdm
WDM2       42   swmpgwel.wdm
MESSU      43   swamp-base2.ech
           91   swamp-base2.per
           92   swamp-base2.imp
           93   swamp-base2.rch
           94   swamp-base2.plt
END FILES

OPN SEQUENCE
    INGRP              INDELT  1:00

      PERLND     122
      PERLND     222
      PERLND     522
  *** RCHRES     220

      PERLND     123
      PERLND     223
      PERLND     523
  *** RCHRES     230

      PERLND     121
      PERLND     221
      PERLND     521
      RCHRES     210

      PERLND     116
      PERLND     216
      PERLND     616
      RCHRES     160

      PERLND     117
      PERLND     217
      PERLND     517
      PERLND     617
      RCHRES     170

      PERLND     120
      PERLND     220
      PERLND     520
      PERLND     620
      RCHRES     200

      PERLND     119
      PERLND     219
      PERLND     519
      PERLND     619
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    RCHRES     190

    PERLND     118
    PERLND     218
    PERLND     518
    PERLND     618
    RCHRES     180

    PERLND     115
    PERLND     215
    PERLND     515
    PERLND     615
    RCHRES     150

    PERLND     114
    PERLND     214
    PERLND     514
    PERLND     614
*** RCHRES     140

    PERLND     101
    PERLND     201
    PERLND     501
*** RCHRES      10

    PERLND     102
    PERLND     202
    PERLND     302
    IMPLND     302
    PERLND     502
    PERLND     602
    RCHRES      20

    PERLND     113
    PERLND     213
    PERLND     513
    PERLND     613
    RCHRES     130

    PERLND     112
    PERLND     612
    PERLND     142
    PERLND     542
    PERLND     642
    RCHRES     120

    PERLND     110
    PERLND     210
    PERLND     510
    PERLND     610
    PERLND     140
    PERLND     540
    PERLND     640
    RCHRES     100

    PERLND     109
    PERLND     209
    PERLND     509
    PERLND     609
    PERLND     139
    PERLND     639
    RCHRES      90

    PERLND     111
    PERLND     211
    PERLND     511
*** RCHRES     110
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      PERLND     108
      PERLND     208
      PERLND     508
      PERLND     608
      RCHRES      80

      PERLND     103
      PERLND     203
      PERLND     503
      PERLND     603
      RCHRES      30

      PERLND     104
      PERLND     204
      PERLND     504
      PERLND     604
      RCHRES      40

      PERLND     106
      PERLND     206
      PERLND     606
      RCHRES      60

      PERLND     107
      PERLND     207
      PERLND     507
      PERLND     607
  *** RCHRES      70

      PERLND     105
      PERLND     205
      PERLND     605
      RCHRES      50

      COPY       100
      COPY       110
      COPY       200
      COPY       300
      COPY       400
    END INGRP
END OPN SEQUENCE

PERLND

  ACTIVITY
    <PLS >               Active Sections                               ***
    x -  x ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
  101  642    1    1    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
     <PLS> ******************** Print-flags ************************ PIVL  PYR
    x -  x ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC *********
  101  642    5    5    5                                                1   12
  END PRINT-INFO

  GEN-INFO
    <PLS >      Name                  Unit-systems   Printer***
    x -  x                                t-series Engl Metr***
                                           in  out        ***
  101     Forest (10)                      1    1   91    0
  102     Forest (20)                      1    1   91    0
  103     Forest (30)                      1    1   91    0
  104     Forest (40)                      1    1   91    0
  105     Forest (50)                      1    1   91    0
  106     Forest (60)                      1    1   91    0
  107     Forest (70)                      1    1   91    0
  108     Forest (80)                      1    1   91    0
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109	Forest (91)	1	1	91	0
139	Forest (92)	1	1	91	0
110	Forest (101)	1	1	91	0
140	Forest (102)	1	1	91	0
111	Forest (110)	1	1	91	0
112	Forest (121)	1	1	91	0
142	Forest (122)	1	1	91	0
113	Forest (130)	1	1	91	0
114	Forest (140)	1	1	91	0
115	Forest (150)	1	1	91	0
116	Forest (160)	1	1	91	0
117	Forest (170)	1	1	91	0
118	Forest (180)	1	1	91	0
119	Forest (190)	1	1	91	0
120	Forest (200)	1	1	91	0
121	Forest (210)	1	1	91	0
122	Forest (220)	1	1	91	0
123	Forest (230)	1	1	91	0
201	Ag/Pasture (10)	1	1	91	0
202	Ag/Pasture (20)	1	1	91	0
203	Ag/Pasture (30)	1	1	91	0
204	Ag/Pasture (40)	1	1	91	0
205	Ag/Pasture (50)	1	1	91	0
206	Ag/Pasture (60)	1	1	91	0
207	Ag/Pasture (70)	1	1	91	0
208	Ag/Pasture (80)	1	1	91	0
209	Ag/Pasture (91)	1	1	91	0
210	Ag/Pasture (101)	1	1	91	0
211	Ag/Pasture (110)	1	1	91	0
213	Ag/Pasture (130)	1	1	91	0
214	Ag/Pasture (140)	1	1	91	0
215	Ag/Pasture (150)	1	1	91	0
216	Ag/Pasture (160)	1	1	91	0
217	Ag/Pasture (170)	1	1	91	0
218	Ag/Pasture (180)	1	1	91	0
219	Ag/Pasture (190)	1	1	91	0
220	Ag/Pasture (200)	1	1	91	0
221	Ag/Pasture (210)	1	1	91	0
222	Ag/Pasture (220)	1	1	91	0
223	Ag/Pasture (230)	1	1	91	0
302	Urban-Pervious (20)	1	1	91	0
501	Recharge Wetland (10)	1	1	91	0
502	Recharge Wetland (20)	1	1	91	0
503	Recharge Wetland (30)	1	1	91	0
504	Recharge Wetland (40)	1	1	91	0
507	Recharge wetland (70)	1	1	91	0
508	Recharge wetland (80)	1	1	91	0
509	Recharge wetland (91)	1	1	91	0
510	Recharge wetland (101)	1	1	91	0
540	Recharge wetland (102)	1	1	91	0
511	Recharge wetland (110)	1	1	91	0
542	Recharge wetland (122)	1	1	91	0
513	Recharge wetland (130)	1	1	91	0
514	Recharge wetland (140)	1	1	91	0
515	Recharge wetland (150)	1	1	91	0
517	Recharge wetland (170)	1	1	91	0
518	Recharge wetland (180)	1	1	91	0
519	Recharge wetland (190)	1	1	91	0
520	Recharge Wetland (200)	1	1	91	0
521	Recharge Wetland (210)	1	1	91	0
522	Recharge Wetland (220)	1	1	91	0
523	Recharge Wetland (230)	1	1	91	0
602	Discharge wetland (20)	1	1	91	0
603	Discharge wetland (30)	1	1	91	0
604	Discharge wetland (40)	1	1	91	0
605	Discharge wetland (50)	1	1	91	0

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  606     Discharge wetland (60)           1    1   91    0
  607     Discharge wetland (70)           1    1   91    0
  608     Discharge wetland (80)           1    1   91    0
  609     Discharge wetland (91)           1    1   91    0
  639     Discharge wetland (92)           1    1   91    0
  610     Discharge wetland (101)          1    1   91    0
  640     Discharge wetland (102)          1    1   91    0
  612     Discharge wetland (121)          1    1   91    0
  642     Discharge wetland (122)          1    1   91    0
  613     Discharge wetland (130)          1    1   91    0
  614     Discharge wetland (140)          1    1   91    0
  615     Discharge wetland (150)          1    1   91    0
  616     Discharge wetland (160)          1    1   91    0
  617     Discharge wetland (170)          1    1   91    0
  618     Discharge wetland (180)          1    1   91    0
  619     Discharge wetland (190)          1    1   91    0
  620     Discharge wetland (200)          1    1   91    0
  END GEN-INFO

*** ELDAT = land use elevation - elevation of Laona 6 SW station (1650 ft);
***  Laona 6 SW is documented at 1524.5 ft; topo map suggests ~1650 ft
  ATEMP-DAT
*** <PLS >     ELDAT   AIRTEMP
*** x -  x      (ft)   (deg F)
Forest ***
  101           127.      10.0
  102            36.      10.0
  103            42.      10.0
  104            -8.      10.0
  105           -91.      10.0
  106           -77.      10.0
  107           -75.      10.0
  108           -39.      10.0
  109           -43.      10.0
  139           -43.      10.0
  110           -46.      10.0
  140           -46.      10.0
  111             9.      10.0
  112           -31.      10.0
  142           -31.      10.0
  113           -50.      10.0
  114           -27.      10.0
  115           -36.      10.0
  116            38.      10.0
  117            -2.      10.0
  118           -14.      10.0
  119            -3.      10.0
  120           -18.      10.0
  121            62.      10.0
  122           106.      10.0
  123           110.      10.0

Ag/Pasture ***
  201            65.      10.0
  202            17.      10.0
  203            40.      10.0
  204            13.      10.0
  205           -96.      10.0
  206           -84.      10.0
  207           -90.      10.0
  208           -63.      10.0
  209           -61.      10.0
  210           -40.      10.0
  211            -8.      10.0
  213           -36.      10.0
  214            -6.      10.0
  215           -59.      10.0
  216           -46.      10.0
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  217           -37.      10.0
  218           -12.      10.0
  219            23.      10.0
  220           -19.      10.0
  221            73.      10.0
  222            77.      10.0
  223           153.      10.0

Urban ***
  302           -28.      10.0

Recharge wetland ***
  501            96.      10.0
  502           -24.      10.0
  503           -81.      10.0
  504           -46.      10.0
  507           -79.      10.0
  508           -46.      10.0
  509           -57.      10.0
  510           -54.      10.0
  540           -54.      10.0
  511           -12.      10.0
  542           -26.      10.0
  513           -56.      10.0
  514           -23.      10.0
  515           -58.      10.0
  517           -64.      10.0
  518           -59.      10.0
  519            -1.      10.0
  520           -45.      10.0
  521             7.      10.0
  522            22.      10.0
  523            63.      10.0

Discharge wetland ***
  602           -24.      10.0
  603           -81.      10.0
  604           -99.      10.0
  605          -111.      10.0
  606          -115.      10.0
  607           -93.      10.0
  608          -112.      10.0
  609          -112.      10.0
  639          -112.      10.0
  610           -97.      10.0
  640           -97.      10.0
  612           -84.      10.0
  642           -84.      10.0
  613           -66.      10.0
  614           -64.      10.0
  615           -57.      10.0
  616           -45.      10.0
  617           -70.      10.0
  618           -55.      10.0
  619           -62.      10.0
  620           -53.      10.0

  END ATEMP-DAT

  ICE-FLAG
*** <PLS > Ice
*** x -  x flag
  101  642    1
  END ICE-FLAG

  SNOW-PARM1
*** <PLS >       LAT     MELEV     SHADE    SNOWCF    COVIND
*** x -  x   degrees      (ft)                          (in)
```

Forest ***					
101	45.5	1777.	0.75	1.25	0.3
102	45.5	1686.	0.75	1.25	0.3
103	45.5	1692.	0.75	1.25	0.3
104	45.5	1641.	0.75	1.25	0.3
105	45.5	1559.	0.75	1.25	0.3
106	45.5	1573.	0.75	1.25	0.3
107	45.5	1575.	0.75	1.25	0.3
108	45.5	1612.	0.75	1.25	0.3
109	45.5	1607.	0.75	1.25	0.3
139	45.5	1607.	0.75	1.25	0.3
110	45.5	1604.	0.75	1.25	0.3
140	45.5	1604.	0.75	1.25	0.3
111	45.5	1658.	0.75	1.25	0.3
112	45.5	1619.	0.75	1.25	0.3
142	45.5	1619.	0.75	1.25	0.3
113	45.5	1601.	0.75	1.25	0.3
114	45.5	1623.	0.75	1.25	0.3
115	45.5	1614.	0.75	1.25	0.3
116	45.5	1688.	0.75	1.25	0.3
117	45.5	1648.	0.75	1.25	0.3
118	45.5	1636.	0.75	1.25	0.3
119	45.5	1647.	0.75	1.25	0.3
120	45.5	1632.	0.75	1.25	0.3
121	45.5	1712.	0.75	1.25	0.3
122	45.5	1756.	0.75	1.25	0.3
123	45.5	1760.	0.75	1.25	0.3
Ag/Pasture ***					
201	45.5	1715.	0.40	1.25	0.3
202	45.5	1667.	0.40	1.25	0.3
203	45.5	1690.	0.40	1.25	0.3
204	45.5	1663.	0.40	1.25	0.3
205	45.5	1554.	0.40	1.25	0.3
206	45.5	1566.	0.40	1.25	0.3
207	45.5	1560.	0.40	1.25	0.3
208	45.5	1587.	0.40	1.25	0.3
209	45.5	1589.	0.40	1.25	0.3
210	45.5	1610.	0.40	1.25	0.3
211	45.5	1642.	0.40	1.25	0.3
213	45.5	1614.	0.40	1.25	0.3
214	45.5	1644.	0.40	1.25	0.3
215	45.5	1591.	0.40	1.25	0.3
216	45.5	1604.	0.40	1.25	0.3
217	45.5	1613.	0.40	1.25	0.3
218	45.5	1638.	0.40	1.25	0.3
219	45.5	1673.	0.40	1.25	0.3
220	45.5	1631.	0.40	1.25	0.3
221	45.5	1723.	0.40	1.25	0.3
222	45.5	1727.	0.40	1.25	0.3
223	45.5	1803.	0.40	1.25	0.3
Urban ***					
302	45.5	1622.	0.40	1.25	0.3
Recharge wetland ***					
501	45.5	1746.	0.70	1.25	0.3
502	45.5	1626.	0.70	1.25	0.3
503	45.5	1569.	0.70	1.25	0.3
504	45.5	1604.	0.70	1.25	0.3
507	45.5	1571.	0.70	1.25	0.3
508	45.5	1604.	0.70	1.25	0.3
509	45.5	1593.	0.70	1.25	0.3
510	45.5	1596.	0.70	1.25	0.3
540	45.5	1596.	0.70	1.25	0.3
511	45.5	1638.	0.70	1.25	0.3

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  542          45.5     1624.      0.70      1.25       0.3
  513          45.5     1595.      0.70      1.25       0.3
  514          45.5     1627.      0.70      1.25       0.3
  515          45.5     1593.      0.70      1.25       0.3
  517          45.5     1586.      0.70      1.25       0.3
  518          45.5     1591.      0.70      1.25       0.3
  519          45.5     1650.      0.70      1.25       0.3
  520          45.5     1605.      0.70      1.25       0.3
  521          45.5     1657.      0.70      1.25       0.3
  522          45.5     1672.      0.70      1.25       0.3
  523          45.5     1713.      0.70      1.25       0.3

Discharge wetland ***

  602          45.5     1626.      0.70      1.25       0.3
  603          45.5     1569.      0.70      1.25       0.3
  604          45.5     1551.      0.70      1.25       0.3
  605          45.5     1539.      0.70      1.25       0.3
  606          45.5     1535.      0.70      1.25       0.3
  607          45.5     1557.      0.70      1.25       0.3
  608          45.5     1538.      0.70      1.25       0.3
  609          45.5     1538.      0.70      1.25       0.3
  639          45.5     1538.      0.70      1.25       0.3
  610          45.5     1553.      0.70      1.25       0.3
  640          45.5     1553.      0.70      1.25       0.3
  612          45.5     1567.      0.70      1.25       0.3
  642          45.5     1567.      0.70      1.25       0.3
  613          45.5     1584.      0.70      1.25       0.3
  614          45.5     1586.      0.70      1.25       0.3
  615          45.5     1593.      0.70      1.25       0.3
  616          45.5     1606.      0.70      1.25       0.3
  617          45.5     1580.      0.70      1.25       0.3
  618          45.5     1595.      0.70      1.25       0.3
  619          45.5     1588.      0.70      1.25       0.3
  620          45.5     1597.      0.70      1.25       0.3

  END SNOW-PARM1

  SNOW-PARM2
*** <PLS >     RDCSN     TSNOW    SNOEVP    CCFACT    MWATER    MGMELT
*** x -  x             (deg F)                                (in/day)
  101  642       0.1      30.0      0.05    0.0005      0.24      .023

  END SNOW-PARM2

  SNOW-INIT1
*** <PLS > Pack-snow  Pack-ice Pack-watr    RDENPF      DULL    PAKTMP
*** x -  x      (in)      (in)      (in)                       (deg F)
  101  642       2.0       0.0      0.15       0.2     375.0      32.0

  END SNOW-INIT1

  SNOW-INIT2
*** <PLS >    COVINX    XLNMLT    SKYCLR
*** x -  x      (in)      (in)
  101  642      0.01       0.0       1.0
  END SNOW-INIT2

  PWAT-PARM1
*** <PLS >                   Flags
*** x -  x CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE IFFC  HWT
  101  142    1    1    1    1    1    0    0    0    1         0
  201  223    1    1    1    1    1    0    0    0    1         0
  302         1    1    1    1    0    0    0    0    1         0
  501  542    1    3    1    1    0    0    0    0    1         1
  602  642    1    3    1    1    0    0    0    0    1         1
  END PWAT-PARM1
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  PWAT-PARM2
***  <PLS>    FOREST       LZSN   INFILT       LSUR      SLSUR      KVARY      AGWRC
*** x -  x                 (in)  (in/hr)       (ft)                (1/in)    (1/day)
Forest ***
  101            .75       6.35    0.065      300.0      0.058      0.000      0.975
  102            .75       6.35    0.065      250.0      0.072      0.000      0.975
  103            .75       6.35    0.065      300.0      0.058      0.000      0.975
  104            .75       6.35    0.065      300.0      0.054      0.000      0.975
  105            .75       6.35    0.065      300.0      0.031      0.000      0.975
  106            .75       6.35    0.065      300.0      0.050      0.000      0.975
  107            .75       6.35    0.065      300.0      0.050      0.000      0.975
  108            .75       6.35    0.065      300.0      0.057      0.000      0.975
  109            .75       6.35    0.065      300.0      0.039      0.000      0.975
  139            .75       6.35    0.065      300.0      0.039      0.000      0.975
  110            .75       6.35    0.065      350.0      0.030      0.000      0.975
  140            .75       6.35    0.065      350.0      0.030      0.000      0.975
  111            .75       6.35    0.065      300.0      0.043      0.000      0.975
  112            .75       6.35    0.065      300.0      0.046      0.000      0.975
  142            .75       6.35    0.065      300.0      0.046      0.000      0.975
  113            .75       6.35    0.065      400.0      0.010      0.000      0.975
  114            .75       6.35    0.065      300.0      0.055      0.000      0.975
  115            .75       6.35    0.065      300.0      0.042      0.000      0.975
  116            .75       6.35    0.065      300.0      0.063      0.000      0.975
  117            .75       6.35    0.065      300.0      0.041      0.000      0.975
  118            .75       6.35    0.065      300.0      0.051      0.000      0.975
  119            .75       6.35    0.065      250.0      0.085      0.000      0.975
  120            .75       6.35    0.065      300.0      0.061      0.000      0.975
  121            .75       6.35    0.065      300.0      0.064      0.000      0.975
  122            .75       6.35    0.065      250.0      0.090      0.000      0.975
  123            .75       6.35    0.065      250.0      0.076      0.000      0.975

Ag/Pasture ***
  201            0.0       6.35    0.065      300.0      0.056      0.000      0.975
  202            0.0       6.35    0.065      300.0      0.048      0.000      0.975
  203            0.0       6.35    0.065      250.0       0.10      0.000      0.975
  204            0.0       6.35    0.065      300.0      0.058      0.000      0.975
  205            0.0       6.35    0.065      300.0      0.048      0.000      0.975
  206            0.0       6.35    0.065      350.0      0.024      0.000      0.975
  207            0.0       6.35    0.065      350.0      0.012      0.000      0.975
  208            0.0       6.35    0.065      300.0      0.057      0.000      0.975
  209            0.0       6.35    0.065      300.0      0.031      0.000      0.975
  210            0.0       6.35    0.065      350.0      0.014      0.000      0.975
  211            0.0       6.35    0.065      350.0      0.028      0.000      0.975
  213            0.0       6.35    0.065      400.0      0.008      0.000      0.975
  214            0.0       6.35    0.065      200.0      0.186      0.000      0.975
  215            0.0       6.35    0.065      400.0      0.005      0.000      0.975
  216            0.0       6.35    0.065      350.0      0.013      0.000      0.975
  217            0.0       6.35    0.065      350.0      0.022      0.000      0.975
  218            0.0       6.35    0.065      300.0      0.053      0.000      0.975
  219            0.0       6.35    0.065      200.0      0.154      0.000      0.975
  220            0.0       6.35    0.065      300.0      0.031      0.000      0.975
  221            0.0       6.35    0.065      300.0      0.061      0.000      0.975
  222            0.0       6.35    0.065      200.0      0.108      0.000      0.975
  223            0.0       6.35    0.065      200.0      0.134      0.000      0.975

Urban ***
  302            0.2       5.60    0.035      350.0      0.025      0.000      0.985


Recharge wetland ***
  501            .45       6.15    0.037       50.0      0.032      0.000      0.985
  502            .45       6.15    0.037       50.0      0.021      0.000      0.985
  503            .45       6.15    0.037       50.0      0.029      0.000      0.985
  504            .45       6.15    0.037       50.0      0.031      0.000      0.985
  507            .45       6.15    0.037       50.0      0.006      0.000      0.985
  508            .45       6.15    0.037       50.0      0.014      0.000      0.985
  509            .45       6.15    0.037       50.0      0.042      0.000      0.985
  510            .45       6.15    0.037       50.0      0.019      0.000      0.985
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  540          .45     6.15    0.037     50.0    0.019    0.000    0.985
  511          .45     6.15    0.037     50.0    0.006    0.000    0.985
  542          .45     6.15    0.037     50.0    0.006    0.000    0.985
  513          .45     6.15    0.037     50.0    0.007    0.000    0.985
  514          .45     6.15    0.037     50.0    0.022    0.000    0.985
  515          .45     6.15    0.037     50.0    0.003    0.000    0.985
  517          .45     6.15    0.037     50.0    0.002    0.000    0.985
  518          .45     6.15    0.037     50.0    0.029    0.000    0.985
  519          .45     6.15    0.037     50.0    0.025    0.000    0.985
  520          .45     6.15    0.037     50.0    0.029    0.000    0.985
  521          .45     6.15    0.037     50.0    0.033    0.000    0.985
  522          .45     6.15    0.037     50.0    0.023    0.000    0.985
  523          .45     6.15    0.037     50.0    0.017    0.000    0.985

Discharge wetland ***
  602          .45     6.15    0.037     50.0    0.021    0.000    0.985
  603          .45     6.15    0.037     50.0    0.029    0.000    0.985
  604          .45     6.15    0.037     50.0    0.029    0.000    0.985
  605          .45     6.15    0.037     50.0    0.010    0.000    0.985
  606          .45     6.15    0.037     50.0    0.015    0.000    0.985
  607          .45     6.15    0.037     50.0    0.008    0.000    0.985
  608          .45     6.15    0.037     50.0    0.014    0.000    0.985
  609          .45     6.15    0.037     50.0    0.010    0.000    0.985
  639          .45     6.15    0.037     50.0    0.010    0.000    0.985
  610          .45     6.15    0.037     50.0    0.021    0.000    0.985
  640          .45     6.15    0.037     50.0    0.021    0.000    0.985
  612          .45     6.15    0.037     50.0    0.032    0.000    0.985
  642          .45     6.15    0.037     50.0    0.032    0.000    0.985
  613          .45     6.15    0.037     50.0    0.011    0.000    0.985
  614          .45     6.15    0.037     50.0    0.011    0.000    0.985
  615          .45     6.15    0.037     50.0    0.013    0.000    0.985
  616          .45     6.15    0.037     50.0    0.013    0.000    0.985
  617          .45     6.15    0.037     50.0    0.040    0.000    0.985
  618          .45     6.15    0.037     50.0    0.026    0.000    0.985
  619          .45     6.15    0.037     50.0    0.023    0.000    0.985
  620          .45     6.15    0.037     50.0    0.038    0.000    0.985
  END PWAT-PARM2

  PWAT-PARM3
***  <PLS>    PETMAX   PETMIN   INFEXP   INFILD   DEEPFR   BASETP   AGWETP
*** x -  x   (deg F)  (deg F)
  101  142      34.5     28.0      2.0      2.0    0.025    0.000    0.000
  201  223      34.5     28.0      2.0      2.0    0.030    0.000    0.000
  302           34.5     28.0      2.0      2.0    0.030    0.000    0.000
  501  542      34.5     28.0      2.0      2.0    0.030    0.000    0.000
  602  642      34.5     28.0      2.0      2.0    0.030    0.000    0.000
  END PWAT-PARM3

  PWAT-PARM4
*** <PLS >     CEPSC     UZSN     NSUR    INTFW      IRC    LZETP
*** x -  x      (in)     (in)                    (1/day)
  101  142     0.000     0.55     0.25    0.900     0.30      0.7
  201  223     0.000     0.75     0.15    1.275     0.45      0.7
  302          0.000     0.85     0.07    1.125     0.45      0.6
  501  542     0.000     0.55     0.05    0.475     0.45      0.6
  602  642     0.000     0.55     0.05    0.475     0.45      0.6
  END PWAT-PARM4

  PWAT-PARM6
***  <PLS>     MELEV     BELV   GWDATM      PCW      PGW     UPGW
*** x -  x      (ft)     (ft)     (ft)      (-)      (-)      (-)
  501          1746.    1744.    1726.     0.24     0.31     0.31
  502          1626.    1624.    1606.     0.30     0.35     0.35
  503          1569.    1567.    1549.     0.21     0.30     0.30
  504          1604.    1602.    1584.     0.24     0.29     0.29
  507          1571.    1569.    1551.     0.26     0.27     0.27
  508          1604.    1602.    1584.     0.20     0.30     0.30
  509          1593.    1591.    1573.     0.25     0.29     0.29
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  510         1596.     1594.     1576.      0.25      0.29      0.29
  540         1596.     1594.     1576.      0.25      0.29      0.29
  511         1638.     1636.     1618.      0.23      0.31      0.31
  542         1624.     1622.     1604.      0.23      0.31      0.31
  513         1595.     1593.     1575.      0.25      0.28      0.28
  514         1627.     1625.     1607.      0.24      0.32      0.32
  515         1593.     1591.     1573.      0.26      0.32      0.32
  517         1586.     1584.     1566.      0.21      0.30      0.30
  518         1591.     1589.     1571.      0.20      0.32      0.32
  519         1650.     1648.     1630.      0.23      0.31      0.31
  520         1605.     1603.     1585.      0.21      0.28      0.28
  521         1657.     1655.     1637.      0.25      0.31      0.31
  522         1672.     1670.     1652.      0.20      0.31      0.31
  523         1713.     1711.     1693.      0.22      0.31      0.31

  602         1626.     1624.     1606.      0.30      0.35      0.35
  603         1569.     1567.     1549.      0.21      0.30      0.30
  604         1551.     1549.     1531.      0.24      0.29      0.29
  605         1539.     1537.     1519.      0.20      0.28      0.28
  606         1535.     1533.     1515.      0.27      0.33      0.33
  607         1557.     1555.     1537.      0.26      0.27      0.27
  608         1538.     1536.     1518.      0.20      0.30      0.30
  609         1538.     1536.     1518.      0.25      0.29      0.29
  639         1538.     1536.     1518.      0.25      0.29      0.29
  610         1553.     1551.     1533.      0.25      0.29      0.29
  640         1553.     1551.     1533.      0.25      0.29      0.29
  612         1567.     1565.     1547.      0.23      0.31      0.31
  642         1567.     1565.     1547.      0.23      0.31      0.31
  613         1584.     1582.     1564.      0.25      0.28      0.28
  614         1586.     1584.     1566.      0.24      0.32      0.32
  615         1593.     1591.     1573.      0.26      0.32      0.32
  616         1606.     1604.     1586.      0.22      0.31      0.31
  617         1580.     1578.     1560.      0.21      0.30      0.30
  618         1595.     1593.     1575.      0.20      0.32      0.32
  619         1588.     1586.     1568.      0.23      0.31      0.31
  620         1597.     1595.     1577.      0.21      0.28      0.28
  END PWAT-PARM6

  PWAT-PARM7
***  <PLS>    STABNO      SRRC     SREXP     IFWSC     DELTA    UELFAC    LELFAC
*** x -  x         -     (/hr)       (-)      (in)      (in)       (-)       (-)
  501  642         1       0.5      1.00       1.0
  END PWAT-PARM7


  MON-INTERCEP
*** <PLS >  Interception storage capacity at start of each month (in)
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  101  142 0.02 0.02 0.05 0.07 0.09 0.10 0.10 0.10 0.08 0.08 0.06 0.02
  201  223 0.01 0.01 0.02 0.02 0.02 0.02 0.08 0.08 0.06 0.03 0.01 0.01
  302      0.01 0.01 0.02 0.02 0.02 0.02 0.08 0.08 0.06 0.03 0.01 0.01
  501  542 0.01 0.01 0.02 0.02 0.02 0.02 0.08 0.08 0.06 0.03 0.01 0.01
  602  642 0.01 0.01 0.02 0.02 0.02 0.02 0.08 0.08 0.06 0.03 0.01 0.01
  END MON-INTERCEP

  MON-UZSN
*** <PLS >  Upper zone storage at start of each month  (inches)
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  101  142 1.15 1.10 0.75 0.50 0.50 0.25 0.05 0.10 0.25 0.50 1.25 1.20
  201  223  0.8  0.8 0.85 0.85 0.90 0.10 0.10 0.15 0.30 0.60 0.90  0.9
  END MON-UZSN

  MON-LZETPARM
*** <PLS >  Lower zone evapotranspiration parm. at start of each month
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  101  142  .30  .30 0.35 0.40 0.42 0.43 0.43 0.45  .40  .35  .30  .30
  201  223  .20  .25 0.30 0.30 0.35 0.35 0.35 0.35  0.3  0.3 0.25  .15
  302       .20  .25 0.30 0.30 0.35 0.35 0.35 0.35  0.3  0.3 0.25  .15
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  501  542  .20  .25 0.30 0.30 0.35 0.35 0.35 0.35  0.3  0.3 0.25  .15
  601  642  .20  .25 0.30 0.30 0.35 0.35 0.35 0.35  0.3  0.3 0.25  .15
  END MON-LZETPARM

  PWAT-STATE1
***  <PLS>  PWATER state variables (in)
*** Verification years only!
*** x -  x      CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
  101  142       0.0       0.0      0.40       0.0      4.70      0.40       0.0 ***
  201  223       0.0       0.0      0.30       0.0      4.60      0.40       0.0 ***
  302            0.0       0.0      0.30       0.0      4.60      0.40       0.0 ***
  501  542       0.0       0.2      1.00       1.0      8.90      2.35       0.0 ***
  602  642       0.0       0.2      1.00       1.0      8.90      2.35       0.0 ***
*** Calibration years only!
*** x -  x      CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
  101  142       0.0       0.0      1.00       0.0      7.50      0.40       0.0
  201  223       0.0       0.0      1.15       0.0      7.50      0.40       0.0
  302            0.0       0.0      1.15       0.0      7.50      0.40       0.0
  501  542       0.0       0.2      2.25       1.0     15.30      2.35       0.0
  602  642       0.0       0.2      2.25       1.0     15.30      2.35       0.0
  END PWAT-STATE1

END PERLND

IMPLND

  ACTIVITY
*** <ILS >               Active Sections
*** x -  x ATMP SNOW IWAT  SLD  IWG IQAL
  301  323    1    1    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    x -  x ATMP SNOW IWAT  SLD  IWG IQAL *********
  301  323    5    5    5                   1   12
  END PRINT-INFO

  GEN-INFO
*** <ILS >      Name             Unit-systems   Printer
*** <ILS >                           t-series Engl Metr
*** x -  x                            in  out
  301  323Urban-Impervious             1    1   92    0
  END GEN-INFO

  ATEMP-DAT
*** <ILS >     ELDAT   AIRTEMP
*** x -  x      (ft)   (deg F)
  302           -28.      10.0
  END ATEMP-DAT

  ICE-FLAG
*** <ILS > Ice
*** x -  x flag
  301  323    1
  END ICE-FLAG

  SNOW-PARM1
*** <ILS >       LAT     MELEV     SHADE    SNOWCF    COVIND
*** x -  x   degrees      (ft)                          (in)
  302           45.5     1622.       0.1      1.25       0.3
  END SNOW-PARM1

  SNOW-PARM2
*** <ILS >     RDCSN     TSNOW    SNOEVP    CCFACT    MWATER    MGMELT
*** x -  x             (deg F)                                (in/day)
  302            0.1      30.0      0.05     0.004      0.24      .023
  END SNOW-PARM2
```

```
  SNOW-INIT1
*** <ILS > Pack-snow  Pack-ice Pack-watr    RDENPF      DULL    PAKTMP
*** x -  x      (in)      (in)      (in)                       (deg F)
  302            1.5       0.0      0.15       0.2     375.0      32.0
  END SNOW-INIT1

  SNOW-INIT2
*** <ILS >    COVINX    XLNMLT    SKYCLR
*** x -  x      (in)      (in)
  302           0.01       0.0       1.0
  END SNOW-INIT2

  IWAT-PARM1
*** <ILS >        Flags
*** x -  x CSNO RTOP  VRS  VNN RTLI
  302         1    1    1    0    0
  END IWAT-PARM1

  IWAT-PARM2
*** <ILS >      LSUR     SLSUR      NSUR     RETSC
*** x -  x      (ft)                          (ft)
  302          300.0     0.010       0.1       0.0
  END IWAT-PARM2

  MON-RETN
*** <ILS >  Retention storage capacity at start of each month (in)
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  302      .036 .036 .049 .049 .049 .065 .065 .065 .049 .049 .049 .036
  END MON-RETN

  IWAT-STATE1
*** <ILS >  IWATER state variables (inches)
*** x -  x      RETS      SURS
  302          0.001     0.001
  END IWAT-STATE1

END IMPLND

RCHRES

  ACTIVITY
*** RCHRES  Active sections
*** x -  x HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG
   10  230    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
*** RCHRES  Printout level flags
*** x -  x HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR
   10  230    5                                                1   12
  END PRINT-INFO

  GEN-INFO
***              Name        Nexits   Unit Systems   Printer
*** RCHRES--------------------          t-series  Engl Metr LKFG
*** x -  x                                in  out
   10 *** Upper L. Metonga        1         1    1   93    0    0
   20     Lower L. Metonga        1         1    1   93    0    1
   30     Trib to Rice Lake       1         1    1   93    0    0
   40     Gliske Creek            1         1    1   93    0    0
   50     Swamp Ck. b. Rice L.    1         1    1   93    0    0
   60     Rice Lake               1         1    1   93    0    1
   70 *** Mole Lake               1         1    1   93    0    1
   80     Swamp Ck. a. Rice L.    1         1    1   93    0    0
   90     Swamp:Rice-Outlet L     1         1    1   93    0    0
  100     Swamp:Rice-Outlet M     1         1    1   93    0    0
  110 *** Oak Lake                1         1    1   93    0    1
```

```
  120     Swamp:Rice-Outlet U     1         1    1   93    0    0
  130     Outlet Creek            1         1    1   93    0    0
  140 *** Newly discov trib       1         1    1   93    0    0
  150     Swamp Ck. a. Outlet     1         1    1   93    0    0
  160     Swamp Ck. b. Lucerne    1         1    1   93    0    0
  170     Swamp Ck. a. Hemlock    1         1    1   93    0    0
  180     Lower Hemlock Creek     1         1    1   93    0    0
  190     Hemlock Ck. b. GHL      1         1    1   93    0    0
  200     Ground Hemlock Lake     1         1    1   93    0    1
  210     Lake Lucerne            1         1    1   93    0    1
  220 *** Trib. to L. Lucerne     1         1    1   93    0    0
  230 *** Trib. nr. L. Lucerne    1         1    1   93    0    0
  END GEN-INFO

  HYDR-PARM1
***         Flags for HYDR section
    RCHRES  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
    x -  x  FG FG FG FG  possible   exit *** possible   exit     possible   exit
   10  230   0  1  1  1    4  0  0  0  0
  END HYDR-PARM1

  HYDR-PARM2
*** RCHRES    FTABNO        LEN     DELTH     STCOR        KS       DB50
*** x -  x              (miles)      (ft)      (ft)                 (in)
   20             20        0.1       0.0    1525.7       0.5       0.01
   30             30        1.6      50.0       0.0       0.5       0.01
   40             40        2.5      60.0       0.0       0.5       0.01
   50             50        1.0       1.0       0.0       0.5       0.01
   60             60        0.1       0.0    1528.7       0.5       0.01
   80             80        0.8       1.0       0.0       0.5       0.01
   90             90        1.0       4.0       0.0       0.5       0.01
  100            100        1.2       6.0       0.0       0.5       0.01
  120            120        0.8      30.0       0.0       0.5       0.01
  130            130        1.8      21.0       0.0       0.5       0.01
  150            150        1.0       3.0       0.0       0.5       0.01
  160            160        2.7      63.0       0.0       0.5       0.01
  170            170        1.1       2.0       0.0       0.5       0.01
  180            180        1.8       2.0       0.0       0.5       0.01
  190            190        1.0       1.0       0.0       0.5       0.01
  200            200        0.1       0.0    1534.6       0.5       0.01
  210            210        0.1       0.0    1572.0       0.5       0.01
  END HYDR-PARM2

  HYDR-INIT
***         Initial conditions for HYDR section
*** RCHRES       VOL  CAT Initial value  of COLIND     initial  value  of OUTDGT
*** x -  x     ac-ft      for each possible   exit  for each possible exit,ft3
   20        54950.0    0  4.0  4.0  4.0  4.0  4.0
   30            0.5    0  4.0  4.0  4.0  4.0  4.0
   40            1.4    0  4.0  4.0  4.0  4.0  4.0
   50            5.0    0  4.0  4.0  4.0  4.0  4.0
   60          110.0    0  4.0  4.0  4.0  4.0  4.0
   80            2.0    0  4.0  4.0  4.0  4.0  4.0
   90            2.0    0  4.0  4.0  4.0  4.0  4.0
  100            1.8    0  4.0  4.0  4.0  4.0  4.0
  120            1.0    0  4.0  4.0  4.0  4.0  4.0
  130            1.5    0  4.0  4.0  4.0  4.0  4.0
  150            2.0    0  4.0  4.0  4.0  4.0  4.0
  160            2.0    0  4.0  4.0  4.0  4.0  4.0
  170            2.5    0  4.0  4.0  4.0  4.0  4.0
  180            3.0    0  4.0  4.0  4.0  4.0  4.0
  190            2.0    0  4.0  4.0  4.0  4.0  4.0
  200         1620.0    0  4.0  4.0  4.0  4.0  4.0
  210        31454.0    0  4.0  4.0  4.0  4.0  4.0
  END HYDR-INIT

END RCHRES
```

```
COPY
  TIMESERIES
  Copy-opn***
*** x -  x  NPT  NMN
  100         0    8
  110         0    7
  200         0   20
  300         0   20
  400         0    2
  END TIMESERIES
END COPY

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   x <Name> x tem strg<-factor->strg <Name>   x   x        <Name> x x  ***

Meteorologic data                                                  ***

WDM1  3022 PRCP  31 ENGLZERO               PERLND 101 642 EXTNL  PREC   1 1
WDM1  3026 TEMP  31 ENGL              SAME PERLND 101 642 EXTNL  GATMP  1 1
WDM1  3001 TEMP  31 ENGL              SAME PERLND 101 642 EXTNL  DTMPG  1 1
WDM1  2041 CLDC  31 ENGL              SAME PERLND 101 642 EXTNL  CLOUD  1 1
WDM1  3021 WIND  31 ENGL                   PERLND 101 642 EXTNL  WINMOV 1 1
WDM1  2043 SOLR  31 ENGL              SAME PERLND 101 642 EXTNL  SOLRAD 1 1
*** Green Bay AP - computed (Penman) evaporation - from MICIS
WDM1  3017 EVAP  31 ENGL         1.00      PERLND 101 302 EXTNL  PETINP 1 1
WDM1  3017 EVAP  31 ENGL         0.80      PERLND 501 642 EXTNL  PETINP 1 1


WDM1  3022 PRCP  31 ENGLZERO               IMPLND 301 323 EXTNL  PREC   1 1
WDM1  3026 TEMP  31 ENGL              SAME IMPLND 301 323 EXTNL  GATMP  1 1
WDM1  3001 TEMP  31 ENGL              SAME IMPLND 301 323 EXTNL  DTMPG  1 1
WDM1  2041 CLDC  31 ENGL              SAME IMPLND 301 323 EXTNL  CLOUD  1 1
WDM1  3021 WIND  31 ENGL                   IMPLND 301 323 EXTNL  WINMOV 1 1
WDM1  2043 SOLR  31 ENGL              SAME IMPLND 301 323 EXTNL  SOLRAD 1 1
WDM1  3017 EVAP  31 ENGL         1.0       IMPLND 301 323 EXTNL  PETINP 1 1

WDM1  3022 PRCP  31 ENGLZERO               RCHRES  10 230 EXTNL  PREC   1 1
WDM1  3017 EVAP  31 ENGL         1.0       RCHRES  10 230 EXTNL  POTEV  1 1

END EXT SOURCES

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
*** generate groundwater levels for wetlands
*** this is computed below as GWEL (ft) + SURS (in) /12
PERLND 501 PWATER GWEL                AVER COPY   200     INPUT  MEAN   1
PERLND 501 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN   1
PERLND 502 PWATER GWEL                AVER COPY   200     INPUT  MEAN   2
PERLND 502 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN   2
PERLND 503 PWATER GWEL                AVER COPY   200     INPUT  MEAN   3
PERLND 503 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN   3
PERLND 504 PWATER GWEL                AVER COPY   200     INPUT  MEAN   4
PERLND 504 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN   4
PERLND 507 PWATER GWEL                AVER COPY   200     INPUT  MEAN   5
PERLND 507 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN   5
PERLND 508 PWATER GWEL                AVER COPY   200     INPUT  MEAN   6
PERLND 508 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN   6
PERLND 509 PWATER GWEL                AVER COPY   200     INPUT  MEAN   7
PERLND 509 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN   7
PERLND 510 PWATER GWEL                AVER COPY   200     INPUT  MEAN   8
PERLND 510 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN   8
PERLND 540 PWATER GWEL                AVER COPY   200     INPUT  MEAN   9
PERLND 540 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN   9
PERLND 511 PWATER GWEL                AVER COPY   200     INPUT  MEAN  10
PERLND 511 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  10
PERLND 542 PWATER GWEL                AVER COPY   200     INPUT  MEAN  11
PERLND 542 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  11
```

```
PERLND 513 PWATER GWEL               AVER COPY   200     INPUT  MEAN  12
PERLND 513 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  12
PERLND 514 PWATER GWEL               AVER COPY   200     INPUT  MEAN  13
PERLND 514 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  13
PERLND 515 PWATER GWEL               AVER COPY   200     INPUT  MEAN  14
PERLND 515 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  14
PERLND 517 PWATER GWEL               AVER COPY   200     INPUT  MEAN  15
PERLND 517 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  15
PERLND 518 PWATER GWEL               AVER COPY   200     INPUT  MEAN  16
PERLND 518 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  16
PERLND 519 PWATER GWEL               AVER COPY   200     INPUT  MEAN  17
PERLND 519 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  17
PERLND 520 PWATER GWEL               AVER COPY   200     INPUT  MEAN  18
PERLND 520 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  18
PERLND 521 PWATER GWEL               AVER COPY   200     INPUT  MEAN  19
PERLND 521 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  19
PERLND 522 PWATER GWEL               AVER COPY   200     INPUT  MEAN  20
PERLND 522 PWATER SURS        0.0833  AVER COPY   200     INPUT  MEAN  20

PERLND 523 PWATER GWEL               AVER COPY   300     INPUT  MEAN   1
PERLND 523 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN   1
PERLND 602 PWATER GWEL               AVER COPY   300     INPUT  MEAN   2
PERLND 602 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN   2
PERLND 603 PWATER GWEL               AVER COPY   300     INPUT  MEAN   3
PERLND 603 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN   3
PERLND 604 PWATER GWEL               AVER COPY   300     INPUT  MEAN   4
PERLND 604 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN   4
PERLND 605 PWATER GWEL               AVER COPY   300     INPUT  MEAN   5
PERLND 605 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN   5
PERLND 606 PWATER GWEL               AVER COPY   300     INPUT  MEAN   6
PERLND 606 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN   6
PERLND 607 PWATER GWEL               AVER COPY   300     INPUT  MEAN   7
PERLND 607 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN   7
PERLND 608 PWATER GWEL               AVER COPY   300     INPUT  MEAN   8
PERLND 608 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN   8
PERLND 609 PWATER GWEL               AVER COPY   300     INPUT  MEAN   9
PERLND 609 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN   9
PERLND 639 PWATER GWEL               AVER COPY   300     INPUT  MEAN  10
PERLND 639 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  10
PERLND 610 PWATER GWEL               AVER COPY   300     INPUT  MEAN  11
PERLND 610 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  11
PERLND 640 PWATER GWEL               AVER COPY   300     INPUT  MEAN  12
PERLND 640 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  12
PERLND 612 PWATER GWEL               AVER COPY   300     INPUT  MEAN  13
PERLND 612 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  13
PERLND 642 PWATER GWEL               AVER COPY   300     INPUT  MEAN  14
PERLND 642 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  14
PERLND 613 PWATER GWEL               AVER COPY   300     INPUT  MEAN  15
PERLND 613 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  15
PERLND 614 PWATER GWEL               AVER COPY   300     INPUT  MEAN  16
PERLND 614 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  16
PERLND 615 PWATER GWEL               AVER COPY   300     INPUT  MEAN  17
PERLND 615 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  17
PERLND 616 PWATER GWEL               AVER COPY   300     INPUT  MEAN  18
PERLND 616 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  18
PERLND 617 PWATER GWEL               AVER COPY   300     INPUT  MEAN  19
PERLND 617 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  19
PERLND 618 PWATER GWEL               AVER COPY   300     INPUT  MEAN  20
PERLND 618 PWATER SURS        0.0833  AVER COPY   300     INPUT  MEAN  20

PERLND 619 PWATER GWEL               AVER COPY   400     INPUT  MEAN   1
PERLND 619 PWATER SURS        0.0833  AVER COPY   400     INPUT  MEAN   1
PERLND 620 PWATER GWEL               AVER COPY   400     INPUT  MEAN   2
PERLND 620 PWATER SURS        0.0833  AVER COPY   400     INPUT  MEAN   2

*** creating results for HSPEXP below Rice Lake
*** add all upstream (above Rice Lake) results to results for below Rice lake
*** the downstream results (segs. 30, 40, 50, 60, 70 & western area) are compiled in
```

```
ML/SCH
COPY   100 OUTPUT MEAN   1             SAME COPY   110     INPUT  MEAN   1
COPY   100 OUTPUT MEAN   2             SAME COPY   110     INPUT  MEAN   2
COPY   100 OUTPUT MEAN   3             SAME COPY   110     INPUT  MEAN   3
COPY   100 OUTPUT MEAN   4             SAME COPY   110     INPUT  MEAN   4
COPY   100 OUTPUT MEAN   5             SAME COPY   110     INPUT  MEAN   5
COPY   100 OUTPUT MEAN   6             SAME COPY   110     INPUT  MEAN   6
COPY   100 OUTPUT MEAN   7             SAME COPY   110     INPUT  MEAN   7

*** add groundwater from west of Swamp Creek to segment 30 stream
*** assume same characteristics as segment 30
*** NOTE: this has been replaced by changes in SCHEMATIC block - see segment 30
PERLND 103 PWATER AGWO  ***   423.    SAME RCHRES  30     INFLOW IVOL
PERLND 203 PWATER AGWO  ***    38.    SAME RCHRES  30     INFLOW IVOL
PERLND 503 PWATER AGWO  ***     0.    SAME RCHRES  30     INFLOW IVOL
PERLND 603 PWATER AGWO  ***    97.    SAME RCHRES  30     INFLOW IVOL

END NETWORK

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Aggr Amd ***
<Name>   x        <Name> x x<-factor->strg <Name>   x <Name>qf  tem strg strg***

***  Stream Flows  ***
RCHRES  20 HYDR   RO     1 1          AVER WDM1   802 FLOW   0 ENGL AGGR REPL
RCHRES  30 HYDR   RO     1 1          AVER WDM1   803 FLOW   0 ENGL AGGR REPL
RCHRES  40 HYDR   RO     1 1          AVER WDM1   804 FLOW   0 ENGL AGGR REPL
RCHRES  50 HYDR   RO     1 1          AVER WDM1   805 FLOW   0 ENGL AGGR REPL
RCHRES  60 HYDR   RO     1 1          AVER WDM1   806 FLOW   0 ENGL AGGR REPL
RCHRES  80 HYDR   RO     1 1          AVER WDM1   808 FLOW   0 ENGL AGGR REPL
RCHRES  90 HYDR   RO     1 1          AVER WDM1   809 FLOW   0 ENGL AGGR REPL
RCHRES 100 HYDR   RO     1 1          AVER WDM1   810 FLOW   0 ENGL AGGR REPL
RCHRES 120 HYDR   RO     1 1          AVER WDM1   812 FLOW   0 ENGL AGGR REPL
RCHRES 130 HYDR   RO     1 1          AVER WDM1   813 FLOW   0 ENGL AGGR REPL
RCHRES 150 HYDR   RO     1 1          AVER WDM1   815 FLOW   0 ENGL AGGR REPL
RCHRES 160 HYDR   RO     1 1          AVER WDM1   816 FLOW   0 ENGL AGGR REPL
RCHRES 170 HYDR   RO     1 1          AVER WDM1   817 FLOW   0 ENGL AGGR REPL
RCHRES 180 HYDR   RO     1 1          AVER WDM1   818 FLOW   0 ENGL AGGR REPL
RCHRES 190 HYDR   RO     1 1          AVER WDM1   819 FLOW   0 ENGL AGGR REPL
RCHRES 200 HYDR   RO     1 1          AVER WDM1   820 FLOW   0 ENGL AGGR REPL
RCHRES 210 HYDR   RO     1 1          AVER WDM1   821 FLOW   0 ENGL AGGR REPL

*** Stream Depths ***
RCHRES  20 HYDR   STAGE  1 1          AVER WDM1   852 STGE   0 ENGL AGGR REPL
RCHRES  30 HYDR   STAGE  1 1          AVER WDM1   853 STGE   0 ENGL AGGR REPL
RCHRES  40 HYDR   STAGE  1 1          AVER WDM1   854 STGE   0 ENGL AGGR REPL
RCHRES  50 HYDR   STAGE  1 1          AVER WDM1   855 STGE   0 ENGL AGGR REPL
RCHRES  60 HYDR   STAGE  1 1          AVER WDM1   856 STGE   0 ENGL AGGR REPL
RCHRES  80 HYDR   STAGE  1 1          AVER WDM1   858 STGE   0 ENGL AGGR REPL
RCHRES  90 HYDR   STAGE  1 1          AVER WDM1   859 STGE   0 ENGL AGGR REPL
RCHRES 100 HYDR   STAGE  1 1          AVER WDM1   860 STGE   0 ENGL AGGR REPL
RCHRES 120 HYDR   STAGE  1 1          AVER WDM1   862 STGE   0 ENGL AGGR REPL
RCHRES 130 HYDR   STAGE  1 1          AVER WDM1   863 STGE   0 ENGL AGGR REPL
RCHRES 150 HYDR   STAGE  1 1          AVER WDM1   865 STGE   0 ENGL AGGR REPL
RCHRES 160 HYDR   STAGE  1 1          AVER WDM1   866 STGE   0 ENGL AGGR REPL
RCHRES 170 HYDR   STAGE  1 1          AVER WDM1   867 STGE   0 ENGL AGGR REPL
RCHRES 180 HYDR   STAGE  1 1          AVER WDM1   868 STGE   0 ENGL AGGR REPL
RCHRES 190 HYDR   STAGE  1 1          AVER WDM1   869 STGE   0 ENGL AGGR REPL
RCHRES 200 HYDR   STAGE  1 1          AVER WDM1   870 STGE   0 ENGL AGGR REPL
RCHRES 210 HYDR   STAGE  1 1          AVER WDM1   871 STGE   0 ENGL AGGR REPL

  Snow Depth ***
COPY   100 OUTPUT MEAN   8 1 3.7916E-5AVER WDM1   881 SNOW   0 ENGL AGGR REPL

  Data needed for HSPEXP ***
  Above Rice Lake ***
RCHRES  80 ROFLOW ROVOL  1 1 4.5499E-4     WDM1   891 SIMQ   1 ENGL AGGR REPL
COPY   100 OUTPUT MEAN   1 1 3.7916E-5     WDM1   892 SURO   1 ENGL AGGR REPL
```

```
COPY   100 OUTPUT MEAN   2 1 3.7916E-5     WDM1   893 IFWO   1 ENGL AGGR REPL
COPY   100 OUTPUT MEAN   3 1 3.7916E-5     WDM1   894 AGWO   1 ENGL AGGR REPL
COPY   100 OUTPUT MEAN   4 1 3.7916E-5     WDM1   895 PETX   1 ENGL AGGR REPL
COPY   100 OUTPUT MEAN   5 1 3.7916E-5     WDM1   896 TAET   1 ENGL AGGR REPL
COPY   100 OUTPUT MEAN   6 1 3.7916E-5AVER WDM1   897 UZSX   1 ENGL AGGR REPL
COPY   100 OUTPUT MEAN   7 1 3.7916E-5AVER WDM1   898 LZSX   1 ENGL AGGR REPL

  Below Rice Lake ***
RCHRES  50 ROFLOW ROVOL  1 1 3.0537E-4     WDM1   991 SIMQ   1 ENGL AGGR REPL
COPY   110 OUTPUT MEAN   1 1 2.5448E-5     WDM1   992 SURO   1 ENGL AGGR REPL
COPY   110 OUTPUT MEAN   2 1 2.5448E-5     WDM1   993 IFWO   1 ENGL AGGR REPL
COPY   110 OUTPUT MEAN   3 1 2.5448E-5     WDM1   994 AGWO   1 ENGL AGGR REPL
COPY   110 OUTPUT MEAN   4 1 2.5448E-5     WDM1   995 PETX   1 ENGL AGGR REPL
COPY   110 OUTPUT MEAN   5 1 2.5448E-5     WDM1   996 TAET   1 ENGL AGGR REPL
COPY   110 OUTPUT MEAN   6 1 2.5448E-5AVER WDM1   997 UZSX   1 ENGL AGGR REPL
COPY   110 OUTPUT MEAN   7 1 2.5448E-5AVER WDM1   998 LZSX   1 ENGL AGGR REPL

Hourly Wetland GW Elevations (= GWEL + SURS)  ***
COPY   200 OUTPUT MEAN   1 1          SAME WDM2   901 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN   2 1          SAME WDM2   902 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN   3 1          SAME WDM2   903 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN   4 1          SAME WDM2   904 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN   5 1          SAME WDM2   907 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN   6 1          SAME WDM2   908 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN   7 1          SAME WDM2   909 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN   8 1          SAME WDM2   910 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN   9 1          SAME WDM2   940 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  10 1          SAME WDM2   911 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  11 1          SAME WDM2   942 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  12 1          SAME WDM2   913 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  13 1          SAME WDM2   914 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  14 1          SAME WDM2   915 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  15 1          SAME WDM2   917 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  16 1          SAME WDM2   918 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  17 1          SAME WDM2   919 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  18 1          SAME WDM2   920 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  19 1          SAME WDM2   921 GWEL   1 ENGL      REPL
COPY   200 OUTPUT MEAN  20 1          SAME WDM2   922 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN   1 1          SAME WDM2   923 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN   2 1          SAME WDM2   952 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN   3 1          SAME WDM2   953 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN   4 1          SAME WDM2   954 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN   5 1          SAME WDM2   955 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN   6 1          SAME WDM2   956 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN   7 1          SAME WDM2   957 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN   8 1          SAME WDM2   958 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN   9 1          SAME WDM2   959 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  10 1          SAME WDM2   989 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  11 1          SAME WDM2   960 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  12 1          SAME WDM2   990 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  13 1          SAME WDM2   962 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  14 1          SAME WDM2   992 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  15 1          SAME WDM2   963 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  16 1          SAME WDM2   964 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  17 1          SAME WDM2   965 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  18 1          SAME WDM2   966 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  19 1          SAME WDM2   967 GWEL   1 ENGL      REPL
COPY   300 OUTPUT MEAN  20 1          SAME WDM2   968 GWEL   1 ENGL      REPL
COPY   400 OUTPUT MEAN   1 1          SAME WDM2   969 GWEL   1 ENGL      REPL
COPY   400 OUTPUT MEAN   2 1          SAME WDM2   970 GWEL   1 ENGL      REPL

END EXT TARGETS

SCHEMATIC
<-Volume->                  <--Area-->     <-Volume->  <ML#>        ***
<Name>   #                  <-factor->     <Name>   #               ***

Tributary areas                                                     ***
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Segment  10 (drains to RCHRES 20 - Lake Metonga)                     ***
*** assume removed AGWO contribution area (409.2 acres) is in
*** proportion to existing land types and is only in "direct to stream"

non-wetland to recharge wetland                                      ***
                     Forest ratio is         162.4/    221.2         ***
                         Ag ratio is          31.3/    221.2         ***
PERLND 101                      0.734     PERLND 501      4
PERLND 201                      0.142     PERLND 501      4

non-wetland to discharge wetland                                     ***

non-wetland to stream                                                ***
PERLND 101                     1131.7     RCHRES  20      1
PERLND 101                      311.6     RCHRES  20      6
PERLND 201                      195.6     RCHRES  20      1
PERLND 201                       54.7     RCHRES  20      6

wetland areas to stream                                              ***
PERLND 501                      166.5     RCHRES  20      1
PERLND 501                       42.9     RCHRES  20      6


Segment  20                                                          ***
*** assume removed AGWO contribution area (590.9 acres) is in
*** proportion to existing land types and is only in "direct to stream"

non-wetland to recharge wetland                                      ***
                      Forest ratio is        168.9/    219.8         ***
                         Ag ratio is          94.0/    219.8         ***
Urban ratio IMPLND is .2 *       (             0.0/    219.8)        ***
Urban ratio PERLND is .8 *       (               0/    219.8)        ***
PERLND 102                      0.768     PERLND 502      4
PERLND 202                      0.428     PERLND 502      4
IMPLND 302                      0.000     PERLND 502      5
PERLND 302                      0.000     PERLND 502      4

non-wetland to discharge wetland                                     ***
                      Forest ratio is        188.9/    117.2         ***
                         Ag ratio is          56.3/    117.2         ***
Urban ratio IMPLND is .2 *     (                26/    117.2)        ***
Urban ratio PERLND is .8 *    (                  0/    117.2)        ***
PERLND 102                      1.612     PERLND 602      4
PERLND 202                      0.480     PERLND 602      4
IMPLND 302                      0.044     PERLND 602      5
PERLND 302                      0.177     PERLND 602      4

non-wetland to stream                                                ***
PERLND 102                     1849.7     RCHRES  20      1
PERLND 102                      371.9     RCHRES  20      6
PERLND 202                      437.7     RCHRES  20      1
PERLND 202                       99.0     RCHRES  20      6
IMPLND 302                      93.84     RCHRES  20      2
PERLND 302                      304.0     RCHRES  20      1
PERLND 302                       71.4     RCHRES  20      6

wetland areas to stream                                              ***
PERLND 502                      188.1     RCHRES  20      1
PERLND 502                       31.7     RCHRES  20      6
PERLND 602                      100.3     RCHRES  20      1
PERLND 602                       16.9     RCHRES  20      6


Segment  30                                                          ***
*** assume all new area (6751.7 acres) of AGWO contribution is in
*** proportion to existing types and is direct to stream
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non-wetland to recharge wetland                                      ***
                     Forest ratio is          5.5/      4.8          ***
                        Ag ratio is           0.2/      4.8          ***
PERLND 103                       1.146    PERLND 503      4
PERLND 203                       0.042    PERLND 503      4

non-wetland to discharge wetland                                     ***
                     Forest ratio is        432.6/    264.9          ***
                        Ag ratio is          27.4/    264.9          ***
PERLND 103                       1.633    PERLND 603      4
PERLND 203                       0.103    PERLND 603      4

non-wetland to stream                                                ***
PERLND 103                      1660.0    RCHRES  30      1
PERLND 103                      5669.0    RCHRES  30      7
PERLND 203                       103.4    RCHRES  30      1
PERLND 203                       354.0    RCHRES  30      7

wetland areas to stream                                              ***
PERLND 503                         4.8    RCHRES  30      1
PERLND 503                        13.0    RCHRES  30      7
PERLND 603                       264.9    RCHRES  30      1
PERLND 603                       715.7    RCHRES  30      7


Segment  40                                                          ***

non-wetland to recharge wetland                                      ***
                     Forest ratio is        102.1/     70.8          ***
                        Ag ratio is          37.1/     70.8          ***
PERLND 104                       1.442    PERLND 504      4
PERLND 204                       0.524    PERLND 504      4

non-wetland to discharge wetland                                     ***
                     Forest ratio is        256.9/    295.1          ***
                        Ag ratio is           9.2/    295.1          ***
PERLND 104                       0.871    PERLND 604      4
PERLND 204                       0.031    PERLND 604      4

non-wetland to stream                                                ***
PERLND 104                       947.3    RCHRES  40      1
PERLND 204                       109.6    RCHRES  40      1

wetland areas to stream                                              ***
PERLND 504                        70.8    RCHRES  40      1
PERLND 604                       295.1    RCHRES  40      1


Segment  50                                                          ***
*** assume all new area (110.6 acres) of AGWO contribution is in
*** proportion to existing types and is direct to stream

non-wetland to recharge wetland                                      ***

non-wetland to discharge wetland                                     ***
                     Forest ratio is         75.0/     52.6          ***
                        Ag ratio is          14.8/     52.6          ***
PERLND 105                       1.426    PERLND 605      4
PERLND 205                       0.281    PERLND 605      4

non-wetland to stream                                                ***
PERLND 105                       124.1    RCHRES  50      1
PERLND 105                        81.9    RCHRES  50      7
PERLND 205                         2.2    RCHRES  50      1
PERLND 205                         7.0    RCHRES  50      7

wetland areas to stream                                              ***
PERLND 605                        52.6    RCHRES  50      1
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PERLND 605                       21.7     RCHRES  50      7


Segment  60                                                          ***

non-wetland to recharge wetland                                      ***

non-wetland to discharge wetland                                     ***
                      Forest ratio is        196.6/    410.3         ***
                         Ag ratio is          54.3/    410.3         ***
PERLND 106                      0.479     PERLND 606      4
PERLND 206                      0.132     PERLND 606      4

non-wetland to stream                                                ***
PERLND 106                      278.8     RCHRES  60      1
PERLND 206                      102.3     RCHRES  60      1

wetland areas to stream                                              ***
PERLND 606                      410.3     RCHRES  60      1


Segment  70 (drains to RCHRES 50 - Swamp Creek)                      ***

non-wetland to recharge wetland                                      ***
                      Forest ratio is         17.0/      3.3         ***
                         Ag ratio is           0.7/      3.3         ***
PERLND 107                      5.152     PERLND 507      4
PERLND 207                      0.212     PERLND 507      4

non-wetland to discharge wetland                                     ***
                      Forest ratio is        125.0/    174.3         ***
                         Ag ratio is          11.3/    174.3         ***
PERLND 107                      0.717     PERLND 607      4
PERLND 207                      0.065     PERLND 607      4

non-wetland to stream                                                ***
PERLND 107                      241.1     RCHRES  50      1
PERLND 207                       86.3     RCHRES  50      1

wetland areas to stream                                              ***
PERLND 507                      3.300     RCHRES  50      1
PERLND 607                     174.30     RCHRES  50      1


Segment  80                                                          ***
*** assume removed AGWO contribution area (112.8 acres) is in
*** proportion to existing land types and is only in "direct to stream"
*** handle added AGWO area (146.0 acres) from segment 250 separately

non-wetland to recharge wetland                                      ***
                      Forest ratio is        177.7/     82.0         ***
                         Ag ratio is          14.1/     82.0         ***
PERLND 108                      2.167     PERLND 508      4
PERLND 208                      0.172     PERLND 508      4

non-wetland to discharge wetland                                     ***
                      Forest ratio is        103.7/    115.5         ***
                         Ag ratio is          20.5/    115.5         ***
PERLND 108                      0.898     PERLND 608      4
PERLND 208                      0.177     PERLND 608      4

non-wetland to stream                                                ***
PERLND 108                      377.3     RCHRES  80      1
PERLND 108                       77.0     RCHRES  80      6
PERLND 208                       94.2     RCHRES  80      1
PERLND 208                       15.1     RCHRES  80      6

wetland areas to stream                                              ***
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PERLND 508                       73.4     RCHRES  80       1
PERLND 508                        8.6     RCHRES  80       6
PERLND 608                      103.4     RCHRES  80       1
PERLND 608                       12.1     RCHRES  80       6

*** AGWO from segment 250 to rchres 80; use land distribution from
*** segment 250, but use segment 80 perlnds to generate AGWO
PERLND 108                       87.2     RCHRES  80       7
PERLND 208                        1.8     RCHRES  80       7
PERLND 508                        1.5     RCHRES  80       7
PERLND 608                       55.5     RCHRES  80       7


Segment  91 - (90 North of Swamp Ck)                                    ***

non-wetland to recharge wetland                                         ***
                      Forest ratio is          2.0/      2.7            ***
                         Ag ratio is           0.0/      2.7            ***
PERLND 109                      0.741     PERLND 509       4
PERLND 209                  *** 0.000     PERLND 509       4

non-wetland to discharge wetland                                        ***
                      Forest ratio is         37.2/    102.2            ***
                         Ag ratio is          33.3/    102.2            ***
PERLND 109                      0.364     PERLND 609       4
PERLND 209                      0.326     PERLND 609       4

non-wetland to stream                                                   ***
PERLND 109                      334.7     RCHRES  90       1
PERLND 209                      156.1     RCHRES  90       1

wetland areas to stream                                                 ***
PERLND 509                        2.7     RCHRES  90       1
PERLND 609                      102.2     RCHRES  90       1


Segment 92 (390) - (90 South of Swamp Ck)                               ***

non-wetland to discharge wetland                                        ***
                      Forest ratio is         69.5/     93.0            ***
PERLND 139                      0.747     PERLND 639       4

non-wetland to stream                                                   ***
PERLND 139                       21.0     RCHRES  90       1

wetland areas to stream                                                 ***
PERLND 639                       93.0     RCHRES  90       1


Segment 101 - (100 North of Swamp Ck)                                   ***

non-wetland to recharge wetland                                         ***
                      Forest ratio is        191.7/    130.1            ***
                         Ag ratio is          65.7/    130.1            ***
PERLND 110                      1.474     PERLND 510       4
PERLND 210                      0.505     PERLND 510       4

non-wetland to discharge wetland                                        ***
                      Forest ratio is        107.0/    193.5            ***
                         Ag ratio is          24.2/    193.5            ***
PERLND 110                      0.553     PERLND 610       4
PERLND 210                      0.125     PERLND 610       4

non-wetland to stream                                                   ***
PERLND 110                      533.8     RCHRES 100       1
PERLND 210                      140.8     RCHRES 100       1

wetland areas to stream                                                 ***
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PERLND 510                    130.1     RCHRES 100      1
PERLND 610                    193.5     RCHRES 100      1


Segment 102 (400) - (100 South of Swamp Ck)                       ***

non-wetland to recharge wetland                                   ***
                      Forest ratio is        27.0/      1.4       ***
PERLND 140                    19.28     PERLND 540      4

non-wetland to discharge wetland                                  ***
                      Forest ratio is       124.2/     89.8       ***
PERLND 140                    1.383     PERLND 640      4

non-wetland to stream                                             ***
PERLND 140                    109.5     RCHRES 100      1

wetland areas to stream                                           ***
PERLND 540                      1.4     RCHRES 100      1
PERLND 640                     89.8     RCHRES 100      1


Segment 110 (drains to RCHRES 80 - Swamp Creek)                   ***
*** assume removed AGWO contribution area (19.1 acres) is all
*** from forest and is only in "direct to stream"

non-wetland to recharge wetland                                   ***
                      Forest ratio is       147.9/     36.8       ***
                         Ag ratio is          2.8/     36.8       ***
PERLND 111                    4.019     PERLND 511      4
PERLND 211                    0.076     PERLND 511      4

non-wetland to discharge wetland                                  ***

non-wetland to stream                                             ***
PERLND 111                    169.4     RCHRES  80      1
PERLND 111                     19.1     RCHRES  80      6
PERLND 211                      2.5     RCHRES  80      1

wetland areas to stream                                           ***
PERLND 511                     36.8     RCHRES  80      1


Segment 120 - (120 North of Swamp Ck)                             ***

non-wetland to discharge wetland                                  ***
                      Forest ratio is        37.4/     45.2       ***
PERLND 112                    0.827     PERLND 612      4

non-wetland to stream                                             ***
PERLND 112                     80.7     RCHRES 120      1

wetland areas to stream                                           ***
PERLND 612                     45.2     RCHRES 120      1


Segment 122 (420) - (120 South of Swamp Ck)                       ***

non-wetland to recharge wetland                                   ***
                      Forest ratio is        96.4/     21.0       ***
PERLND 142                     4.59     PERLND 542      4

non-wetland to discharge wetland                                  ***
                      Forest ratio is        42.8/     31.6       ***
PERLND 142                     1.35     PERLND 642      4

non-wetland to stream                                             ***
PERLND 142                    119.8     RCHRES 120      1
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wetland areas to stream                                                   ***
PERLND 542                        21.0     RCHRES 120      1
PERLND 642                        31.6     RCHRES 120      1

*** AGWO from segment 290 to rchres 120; use land distribution from
*** segment 290, but use segment 122 perlnds to generate AGWO
*** area = 434.6 acres
PERLND 142                       350.4     RCHRES 120      7
PERLND 142                         9.8     RCHRES 120      7
PERLND 542                        74.3     RCHRES 120      7


Segment 130                                                               ***

non-wetland to recharge wetland                                           ***
                      Forest ratio is         48.4/     56.7              ***
                         Ag ratio is           9.5/     56.7              ***
PERLND 113                       0.854     PERLND 513      4
PERLND 213                       0.168     PERLND 513      4

non-wetland to discharge wetland                                          ***
                      Forest ratio is         17.9/    120.8              ***
                         Ag ratio is           0.9/    120.8              ***
PERLND 113                       0.148     PERLND 613      4
PERLND 213                       0.007     PERLND 613      4

non-wetland to stream                                                     ***
PERLND 113                       425.2     RCHRES 130      1
PERLND 213                       167.0     RCHRES 130      1

wetland areas to stream                                                   ***
PERLND 513                        56.7     RCHRES 130      1
PERLND 613                       120.8     RCHRES 130      1


Segment 140 (drains to RCHRES 120 - Swamp Creek                           ***

non-wetland to recharge wetland                                           ***
                      Forest ratio is          6.0/      3.3              ***
                         Ag ratio is          0.00/      3.3              ***
PERLND 114                       1.818     PERLND 514      4
PERLND 214                   *** 0.000     PERLND 514      4

non-wetland to discharge wetland                                          ***
                      Forest ratio is        130.2/     85.1              ***
                         Ag ratio is          0.00/     85.1              ***
PERLND 114                       1.530     PERLND 614      4
PERLND 214                   *** 0.000     PERLND 614      4

non-wetland to stream                                                     ***
PERLND 114                        56.2     RCHRES 120      1
PERLND 214                         0.2     RCHRES 120      1

wetland areas to stream                                                   ***
PERLND 514                         3.3     RCHRES 120      1
PERLND 614                        85.1     RCHRES 120      1


Segment 150                                                               ***
*** added AGWO area (123.9 acres) from segment 330

non-wetland to recharge wetland                                           ***
                      Forest ratio is         40.9/    247.0              ***
                         Ag ratio is         46.70/    247.0              ***
PERLND 115                       0.166     PERLND 515      4
PERLND 215                       0.189     PERLND 515      4
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non-wetland to discharge wetland                                    ***
                      Forest ratio is        102.4/    144.7        ***
                         Ag ratio is         14.60/    144.7        ***
PERLND 115                       0.708     PERLND 615      4
PERLND 215                       0.101     PERLND 615      4

non-wetland to stream                                               ***
PERLND 115                       171.6     RCHRES 150      1
PERLND 215                       103.7     RCHRES 150      1

wetland areas to stream                                             ***
PERLND 515                       247.0     RCHRES 150      1
PERLND 615                       144.7     RCHRES 150      1

*** AGWO from segment 330 to rchres 150; use land distribution from
*** segment 330, but use segment 150 perlnds to generate AGWO
PERLND 115                       114.8     RCHRES 150      7
PERLND 515                         9.1     RCHRES 150      7


Segment 160                                                         ***

non-wetland to recharge wetland                                     ***

non-wetland to discharge wetland                                    ***
                      Forest ratio is        535.0/    361.1        ***
                         Ag ratio is          3.30/    361.1        ***
PERLND 116                       1.482     PERLND 616      4
PERLND 216                       0.009     PERLND 616      4

non-wetland to stream                                               ***
PERLND 116                         617     RCHRES 160      1
PERLND 216                        37.6     RCHRES 160      1

wetland areas to stream                                             ***
PERLND 616                       361.1     RCHRES 160      1


Segment 170                                                         ***

non-wetland to recharge wetland                                     ***
                      Forest ratio is         57.0/     17.0        ***
                         Ag ratio is           5.0/     17.0        ***
PERLND 117                       3.353     PERLND 517      4
PERLND 217                       0.294     PERLND 517      4

non-wetland to discharge wetland                                    ***
                      Forest ratio is        112.0/    154.2        ***
                         Ag ratio is          40.7/    154.2        ***
PERLND 117                       0.726     PERLND 617      4
PERLND 217                       0.264     PERLND 617      4

non-wetland to stream                                               ***
PERLND 117                       348.2     RCHRES 170      1
PERLND 217                        26.8     RCHRES 170      1

wetland areas to stream                                             ***
PERLND 517                        17.0     RCHRES 170      1
PERLND 617                       154.2     RCHRES 170      1


Segment 180                                                         ***
*** assume all new area (718.3 acres) of AGWO contribution is in
*** proportion to existing types and is direct to stream
*** handle added AGWO area (253.1 acres) from segment 300 separately

non-wetland to recharge wetland                                     ***
                      Forest ratio is        181.0/    116.9        ***
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                         Ag ratio is          5.6/    116.9        ***
PERLND 118                        1.548     PERLND 518      4
PERLND 218                        0.048     PERLND 518      4

non-wetland to discharge wetland                                   ***
                      Forest ratio is       431.4/    365.4        ***
                         Ag ratio is         13.2/    365.4        ***
PERLND 118                        1.181     PERLND 618      4
PERLND 218                        0.036     PERLND 618      4

non-wetland to stream                                              ***
PERLND 118                        997.1     RCHRES 180      1
PERLND 218                         58.0     RCHRES 180      1

wetland areas to stream                                            ***
PERLND 518                        116.9     RCHRES 180      1
PERLND 618                        365.4     RCHRES 180      1

PERLND 118                        533.1     RCHRES 180      7
PERLND 218                         25.4     RCHRES 180      7
PERLND 518                         38.7     RCHRES 180      7
PERLND 618                        121.1     RCHRES 180      7

*** AGWO from segment 300 to rchres 180; use land distribution from
*** segment 300, but use segment 180 perlnds to generate AGWO
PERLND 118                        200.1     RCHRES 180      7
PERLND 218                          2.1     RCHRES 180      7
PERLND 518                         50.9     RCHRES 180      7


Segment 190                                                        ***
*** assume removed AGWO contribution area (188.6 acres) is in
*** proportion to existing land types and is only in "direct to stream"
*** handle added AGWO area (248.1 acres) from segment 310 separately
*** handle added AGWO area (250.2 acres) from segment 320 separately
non-wetland to recharge wetland                                    ***
                      Forest ratio is       142.7/     51.4        ***
                         Ag ratio is          1.2/     51.4        ***
PERLND 119                        2.776     PERLND 519      4
PERLND 219                        0.023     PERLND 519      4

non-wetland to discharge wetland                                   ***
                      Forest ratio is       180.1/    253.5        ***
                         Ag ratio is          0.4/    253.5        ***
PERLND 119                        0.710     PERLND 619      4
PERLND 219                        0.002     PERLND 619      4

non-wetland to stream                                              ***
PERLND 119                        285.3     RCHRES 190      1
PERLND 119                        132.7     RCHRES 190      6
PERLND 219                          4.3     RCHRES 190      1
PERLND 219                          1.3     RCHRES 190      6

wetland areas to stream                                            ***
PERLND 519                         42.2     RCHRES 190      1
PERLND 519                          9.2     RCHRES 190      6
PERLND 619                        208.1     RCHRES 190      1
PERLND 619                         45.4     RCHRES 190      6

*** AGWO from segment 310 to rchres 190; use land distribution from
*** segment 310, but use segment 190 perlnds to generate AGWO
PERLND 119                        199.0     RCHRES 190      7
PERLND 519                         49.1     RCHRES 190      7

*** AGWO from segment 320 to rchres 190; use land distribution from
*** segment 320, but use segment 190 perlnds to generate AGWO
PERLND 119                        213.4     RCHRES 190      7
PERLND 519                         36.8     RCHRES 190      7
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Segment 200                                                     ***
*** assume removed AGWO contribution area (84.3 acres) is in
*** proportion to existing land types and is only in direct to stream

non-wetland to recharge wetland                                 ***
                      Forest ratio is         41.8/     22.5        ***
                         Ag ratio is          15.3/     22.5        ***
PERLND 120                        1.858     PERLND 520      4
PERLND 220                        0.680     PERLND 520      4

non-wetland to discharge wetland                                ***
                      Forest ratio is        174.6/     51.9        ***
                         Ag ratio is           0.0/     51.9        ***
PERLND 120                        3.364     PERLND 620      4
PERLND 220                        0.000     PERLND 620      4

non-wetland to stream                                           ***
PERLND 120                        600.9     RCHRES 200      1
PERLND 120                         72.7     RCHRES 200      6
PERLND 220                         46.2     RCHRES 200      1
PERLND 220                          5.5     RCHRES 200      6

wetland areas to stream                                         ***
PERLND 520                         20.7     RCHRES 200      1
PERLND 520                          1.8     RCHRES 200      6
PERLND 620                         47.6     RCHRES 200      1
PERLND 620                          4.2     RCHRES 200      6


Segment 210                                                     ***
*** assume gw-shed overlap proportionally distributed in forest-to-wetland
***  and forest-to-stream (25% and 75%)
non-wetland to recharge wetland                                 ***
                      Forest ratio is        868.7/    138.9        ***
                         Ag ratio is          57.4/    138.9        ***
PERLND 121    ***              ***6.254     PERLND 521      4
PERLND 121                        1.765     PERLND 521      8
PERLND 121                        4.489     PERLND 521      4
PERLND 221                        0.413     PERLND 521      4

non-wetland to discharge wetland                                ***

non-wetland to stream                                           ***
PERLND 121    ***            *** 2589.7     RCHRES 210      1
PERLND 121                        735.2     RCHRES 210      6
PERLND 121                       1854.5     RCHRES 210      1
PERLND 221                        123.4     RCHRES 210      1

wetland areas to stream                                         ***
PERLND 521                        138.9     RCHRES 210      1


Segment 220 (drains to RCHRES 210 - Lake Lucerne)               ***
*** remove all gw-shed
non-wetland to recharge wetland                                 ***
                      Forest ratio is        298.3/     41.6        ***
                         Ag ratio is          30.3/     41.6        ***
PERLND 122                        7.171     PERLND 522      8
PERLND 222                        0.728     PERLND 522      8

non-wetland to discharge wetland                                ***

non-wetland to stream                                           ***
PERLND 122                        973.9     RCHRES 210      6
PERLND 222                         37.1     RCHRES 210      6
```

```
wetland areas to stream                                               ***
PERLND 522                      41.6     RCHRES 210      6


Segment 230 (drains to RCHRES 210 - Lake Lucerne)                     ***

non-wetland to recharge wetland                                       ***
                      Forest ratio is        460.5/    187.5          ***
                         Ag ratio is          17.1/    187.5          ***
PERLND 123                     2.456     PERLND 523      8
PERLND 223                     0.091     PERLND 523      8

non-wetland to discharge wetland                                      ***

*** assume all gw-shed overlap is non-wetland forest direct to stream
non-wetland to stream                                                 ***
PERLND 123                      78.7     RCHRES 210      1
PERLND 123                    1040.7     RCHRES 210      6
PERLND 223                      56.6     RCHRES 210      6

wetland areas to stream                                               ***
PERLND 523                     187.5     RCHRES 210      6


Reach Connections                                                     ***
RCHRES 210                               RCHRES 160      3
RCHRES 160                               RCHRES 170      3
RCHRES 170                               RCHRES 150      3
RCHRES 200                               RCHRES 190      3
RCHRES 190                               RCHRES 180      3
RCHRES 180                               RCHRES 150      3
RCHRES 150                               RCHRES 120      3
RCHRES  20                               RCHRES 130      3
RCHRES 130                               RCHRES 120      3
RCHRES 120                               RCHRES 100      3
RCHRES 100                               RCHRES  90      3
RCHRES  90                               RCHRES  80      3
RCHRES  80                               RCHRES  60      3
RCHRES  40                               RCHRES  60      3
RCHRES  30                               RCHRES  60      3
RCHRES  60                               RCHRES  50      3

Generate results for HSPEXP                                           ***
Segment  10 (drains to RCHRES 20 - Lake Metonga                       ***

PERLND 101                    1443.3     COPY   100     91
PERLND 201                     250.3     COPY   100     91
PERLND 101                     162.4     COPY   100     93
PERLND 201                    31.300     COPY   100     93
PERLND 501                    221.20     COPY   100     91

Segment  20                                                           ***

PERLND 102                    2221.6     COPY   100     91
PERLND 202                    536.70     COPY   100     91
PERLND 302                    375.36     COPY   100     91
IMPLND 302                     93.84     COPY   100     92
PERLND 102                     357.8     COPY   100     93
PERLND 202                    150.30     COPY   100     93
PERLND 302                     20.80     COPY   100     93
IMPLND 302                       5.2     COPY   100     94
PERLND 502                    219.80     COPY   100     91
PERLND 602                    117.20     COPY   100     91

*** Note: segments 30, 40, 50, 60, 70 compiled for below Rice Lake
Segment  30                                                           ***

PERLND 103                    1660.0     COPY   110     95
```

```
PERLND 203                     103.400     COPY   110      95
PERLND 103                      438.10     COPY   110      95
PERLND 203                      27.600     COPY   110      95
PERLND 503                       4.800     COPY   110      95
PERLND 603                      264.90     COPY   110      95
Extra area to the west of Segment 30  ***
PERLND 103                     4936.       COPY   110      95
PERLND 203                      459.5      COPY   110      95
PERLND 603                     1160.4      COPY   110      95

Segment  40                                                        ***

PERLND 104                       947.3     COPY   110      95
PERLND 204                     109.600     COPY   110      95
PERLND 104                        359.     COPY   110      95
PERLND 204                      46.300     COPY   110      95
PERLND 504                      70.800     COPY   110      95
PERLND 604                      295.10     COPY   110      95

Segment  50                                                        ***

PERLND 105                       124.1     COPY   110      95
PERLND 205                       2.200     COPY   110      95
PERLND 105                      75.000     COPY   110      95
PERLND 205                      14.800     COPY   110      95
PERLND 605                      52.600     COPY   110      95

Segment  60                                                        ***

PERLND 106                       278.8     COPY   110      95
PERLND 206                       102.3     COPY   110      95
PERLND 106                     196.600     COPY   110      95
PERLND 206                      54.300     COPY   110      95
PERLND 606                      410.30     COPY   110      95

Segment  70                                                        ***

PERLND 107                      241.14     COPY   110      95
PERLND 207                      86.300     COPY   110      95
PERLND 107                      141.96     COPY   110      95
PERLND 207                      12.000     COPY   110      95
PERLND 507                       3.300     COPY   110      95
PERLND 607                      174.30     COPY   110      95

Segment  80                                                        ***

PERLND 108                       454.3     COPY   100      91
PERLND 208                     109.300     COPY   100      91
PERLND 108                       281.4     COPY   100      93
PERLND 208                      34.600     COPY   100      93
PERLND 508                      82.000     COPY   100      91
PERLND 608                      115.50     COPY   100      91

Segment  90 (91)                                                   ***

PERLND 109                       334.6     COPY   100      91
PERLND 209                       156.1     COPY   100      91
PERLND 109                        39.3     COPY   100      93
PERLND 209                        33.3     COPY   100      93
PERLND 509                         2.7     COPY   100      91
PERLND 609                       102.2     COPY   100      91

Segment  390 (92)                                                  ***

PERLND 139                        21.0     COPY   100      91
PERLND 139                        69.5     COPY   100      93
PERLND 639                        93.0     COPY   100      91
```

```
Segment 100 (101)                                                  ***

PERLND 110                   533.8     COPY   100     91
PERLND 210                   140.8     COPY   100     91
PERLND 110                   298.8     COPY   100     93
PERLND 210                    89.9     COPY   100     93
PERLND 510                   130.1     COPY   100     91
PERLND 610                   193.5     COPY   100     91

Segment 400 (102)                                                  ***

PERLND 140                   109.4     COPY   100     91
PERLND 140                   151.3     COPY   100     93
PERLND 540                     1.4     COPY   100     91
PERLND 640                    89.8     COPY   100     91

Segment 110 (drains to RCHRES 80 - Swamp Creek)                    ***

PERLND 111                   188.5     COPY   100     91
PERLND 211                   2.500     COPY   100     91
PERLND 111                 147.900     COPY   100     93
PERLND 211                   2.800     COPY   100     93
PERLND 511                  36.800     COPY   100     91

Segment 120 (121)                                                  ***

PERLND 112                    80.7     COPY   100     91
PERLND 112                    37.4     COPY   100     93
PERLND 612                    45.2     COPY   100     91

Segment 420 (122)                                                  ***

PERLND 142                   119.8     COPY   100     91
PERLND 142                   139.1     COPY   100     93
PERLND 542                    21.0     COPY   100     91
PERLND 642                    31.6     COPY   100     91

Segment 130                                                        ***

PERLND 113                  425.20     COPY   100     91
PERLND 213                     167     COPY   100     91
PERLND 113                   66.30     COPY   100     93
PERLND 213                  10.400     COPY   100     93
PERLND 513                  56.700     COPY   100     91
PERLND 613                  120.80     COPY   100     91


Segment 140 (drains to RCHRES 120 - Swamp Creek)                   ***

PERLND 114                    56.2     COPY   100     91
PERLND 214                   0.200     COPY   100     91
PERLND 114                 136.200     COPY   100     93
PERLND 214                   0.000     COPY   100     93
PERLND 514                   3.300     COPY   100     91
PERLND 614                  85.100     COPY   100     91

Segment 150                                                        ***

PERLND 115                   171.6     COPY   100     91
PERLND 215                 103.700     COPY   100     91
PERLND 115                   143.3     COPY   100     93
PERLND 215                  61.300     COPY   100     93
PERLND 515                  247.00     COPY   100     91
PERLND 615                  144.70     COPY   100     91

Segment 160                                                        ***

PERLND 116                  617.00     COPY   100     91
```

```
PERLND 216                    37.600     COPY   100     91
PERLND 116                    535.00     COPY   100     93
PERLND 216                     3.300     COPY   100     93
PERLND 616                    361.10     COPY   100     91

Segment 170                                                             ***

PERLND 117                   348.208     COPY   100     91
PERLND 217                    26.800     COPY   100     91
PERLND 117                   168.992     COPY   100     93
PERLND 217                    45.700     COPY   100     93
PERLND 517                    17.000     COPY   100     91
PERLND 617                    154.20     COPY   100     91

Segment 180                                                             ***

PERLND 118                    997.10     COPY   100     91
PERLND 218                    58.000     COPY   100     91
PERLND 118                    612.40     COPY   100     93
PERLND 218                    18.800     COPY   100     93
PERLND 518                    116.90     COPY   100     91
PERLND 618                    365.40     COPY   100     91

Segment 190                                                             ***

PERLND 119                     418.0     COPY   100     91
PERLND 219                     5.600     COPY   100     91
PERLND 119                     322.8     COPY   100     93
PERLND 219                     1.600     COPY   100     93
PERLND 519                    51.400     COPY   100     91
PERLND 619                    253.50     COPY   100     91


Segment 200                                                             ***

PERLND 120                    673.60     COPY   100     91
PERLND 220                    51.700     COPY   100     91
PERLND 120                    216.40     COPY   100     93
PERLND 220                    15.300     COPY   100     93
PERLND 520                    22.500     COPY   100     91
PERLND 620                    51.900     COPY   100     91


Segment 210                                                             ***

PERLND 121                    2589.7     COPY   100     91
PERLND 221                     123.4     COPY   100     91
PERLND 121                     868.7     COPY   100     93
PERLND 221                    57.400     COPY   100     93
PERLND 521                    138.90     COPY   100     91

Segment 220 (drains to RCHRES 210 - Lake Lucerne)                       ***

PERLND 122                     973.9     COPY   100     91
PERLND 222                    37.100     COPY   100     91
PERLND 122                     298.3     COPY   100     93
PERLND 222                    30.300     COPY   100     93
PERLND 522                    41.600     COPY   100     91


Segment 230 (drains to RCHRES 210 - Lake Lucerne)                       ***

PERLND 123                    1119.4     COPY   100     91
PERLND 223                    56.600     COPY   100     91
PERLND 123                     460.5     COPY   100     93
PERLND 223                    17.100     COPY   100     93
PERLND 523                    187.50     COPY   100     91
```

```
END SCHEMATIC

MASS-LINK

  MASS-LINK        1
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Conversion of Runoff from inches to ac-ft = 0.083333***
PERLND     PWATER PERO       0.0833333     RCHRES         INFLOW IVOL
  END MASS-LINK    1

  MASS-LINK        2
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Conversion of Runoff from inches to ac-ft = 0.083333***
IMPLND     IWATER SURO       0.0833333     RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Reach Transfer of FLOW ***
RCHRES     ROFLOW                          RCHRES         INFLOW
  END MASS-LINK    3

  MASS-LINK        4
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Lateral flows of water - assume upland IFWO goes to groundwater in wetland
PERLND     PWATER SURO                     PERLND         EXTNL  SURLI
PERLND     PWATER IFWO                     PERLND         EXTNL  SURLI
PERLND     PWATER AGWO                     PERLND         EXTNL  SURLI
  END MASS-LINK    4

  MASS-LINK        5
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
IMPLND     IWATER SURO                     PERLND         EXTNL  SURLI
  END MASS-LINK    5

  MASS-LINK        6
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
PERLND     PWATER SURO       0.0833333     RCHRES         INFLOW IVOL
PERLND     PWATER IFWO       0.0833333     RCHRES         INFLOW IVOL
  END MASS-LINK    6

  MASS-LINK        7
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
PERLND     PWATER AGWO       0.0833333     RCHRES         INFLOW IVOL
  END MASS-LINK    7

  MASS-LINK        8
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Lateral flows of water - assume upland IFWO goes to groundwater in wetland
PERLND     PWATER SURO                     PERLND         EXTNL  SURLI
PERLND     PWATER IFWO                     PERLND         EXTNL  SURLI
  END MASS-LINK    8

  MASS-LINK       91
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
PERLND     PWATER SURO   0 0               COPY           INPUT  MEAN   1 0
PERLND     PWATER IFWO   0 0               COPY           INPUT  MEAN   2 0
PERLND     PWATER AGWO   0 0               COPY           INPUT  MEAN   3 0
PERLND     PWATER PET    0 0               COPY           INPUT  MEAN   4 0
```

```
PERLND     PWATER TAET   0 0                COPY           INPUT  MEAN   5 0
PERLND     PWATER UZS    0 0                COPY           INPUT  MEAN   6 0
PERLND     PWATER LZS    0 0                COPY           INPUT  MEAN   7 0
PERLND     SNOW   PDEPTH                    COPY           INPUT  MEAN   8 0
  END MASS-LINK   91

  MASS-LINK       92
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
IMPLND     IWATER SURO   0 0                COPY           INPUT  MEAN   1 0
IMPLND     IWATER PET    0 0                COPY           INPUT  MEAN   4 0
IMPLND     IWATER IMPEV  0 0                COPY           INPUT  MEAN   5 0
IMPLND     SNOW   PDEPTH                    COPY           INPUT  MEAN   8 0
  END MASS-LINK   92

  MASS-LINK       93
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
PERLND     PWATER SURO   0 0                COPY           INPUT  MEAN   1 0
PERLND     PWATER IFWO   0 0                COPY           INPUT  MEAN   2 0
PERLND     PWATER AGWO   0 0                COPY           INPUT  MEAN   3 0
PERLND     PWATER PET    0 0                COPY           INPUT  MEAN   4 0
PERLND     PWATER TAET   0 0                COPY           INPUT  MEAN   5 0
PERLND     PWATER UZS    0 0                COPY           INPUT  MEAN   6 0
PERLND     PWATER LZS    0 0                COPY           INPUT  MEAN   7 0
PERLND     SNOW   PDEPTH                    COPY           INPUT  MEAN   8 0
  END MASS-LINK   93


  MASS-LINK       94
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
IMPLND     IWATER PET    0 0                COPY           INPUT  MEAN   4 0
IMPLND     IWATER IMPEV  0 0                COPY           INPUT  MEAN   5 0
IMPLND     SNOW   PDEPTH                    COPY           INPUT  MEAN   8 0
  END MASS-LINK   94

*** this table is for below Rice Lake results (segs. 30, 40, 50, 60, 70)
  MASS-LINK       95
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
PERLND     PWATER SURO   0 0                COPY           INPUT  MEAN   1 0
PERLND     PWATER IFWO   0 0                COPY           INPUT  MEAN   2 0
PERLND     PWATER AGWO   0 0                COPY           INPUT  MEAN   3 0
PERLND     PWATER PET    0 0                COPY           INPUT  MEAN   4 0
PERLND     PWATER TAET   0 0                COPY           INPUT  MEAN   5 0
PERLND     PWATER UZS    0 0                COPY           INPUT  MEAN   6 0
PERLND     PWATER LZS    0 0                COPY           INPUT  MEAN   7 0
  END MASS-LINK   95

END MASS-LINK


FTABLES
  FTABLE      1
 ROWS COLS ***
    7    2
     DEPTH      FRAC ***
      (IN)           ***
       0.0      0.00
       2.0      0.00
       3.0      0.00
       4.0      0.01
       6.0      0.06
      12.0      0.20
      24.0      0.50
  END FTABLE  1

  FTABLE    160
```

```
ROWS COLS ***
  15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.21       4.7       1.0       1.3      557.
     0.42       4.9       2.0       4.0      357.
     0.63       5.1       3.0       7.9      277.
     0.83       5.2       4.1      12.8      232.
     1.04       5.4       5.2      18.6      203.
     1.25       5.6       6.3      25.3      182.
     1.67       5.9       8.7      41.1      154.
     2.08       6.2      11.3      60.1      136.
     2.50       6.5      13.9      82.1      123.
     4.17      13.8      30.9     231.7       97.
     5.83      21.1      60.0     498.1       87.
     7.50      28.4     101.2     918.9       80.
     9.17      35.6     154.5     1526.       73.
    10.83      42.9     220.0     2349.       68.
 END FTABLE160

 FTABLE    170
ROWS COLS ***
  15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.25       2.7       0.7       0.7      672.
     0.50       2.8       1.4       2.3      429.
     0.75       2.8       2.1       4.5      332.
     1.00       2.9       2.8       7.3      277.
     1.25       2.9       3.5      10.5      242.
     1.50       3.0       4.3      14.2      217.
     2.00       3.1       5.8      22.9      183.
     2.50       3.2       7.4      33.2      161.
     3.00       3.3       9.0      45.0      145.
     5.00       8.7      21.0     125.5      121.
     7.00      14.0      43.7     282.3      112.
     9.00      19.3      77.0     545.5      102.
    11.00      24.7     121.0     940.4       93.
    13.00      30.0     175.7     1490.       86.
 END FTABLE170

 FTABLE    190
ROWS COLS ***
  15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.33       2.7       0.9       1.0      640.
     0.67       2.8       1.8       3.2      412.
     1.00       3.0       2.8       6.3      320.
     1.33       3.1       3.8      10.2      269.
     1.67       3.3       4.8      14.9      236.
     2.00       3.4       5.9      20.3      212.
     2.67       3.7       8.3      33.5      180.
     3.33       4.0      10.8      49.5      159.
     3.80       4.2      13.6      68.5      144.
     6.67       7.5      29.2     197.9      107.
     9.33      10.7      53.4     413.0       94.
    12.00      13.9      86.3     734.5       85.
    14.67      17.2     127.8     1180.       79.
    17.33      20.4     177.9     1767.       73.
 END FTABLE190

 FTABLE    180
ROWS COLS ***
  15    4
```

```
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.38       5.6       2.0       1.5     1011.
     0.75       5.9       4.2       4.7      651.
     1.13       6.2       6.4       9.2      507.
     1.50       6.5       8.8      15.0      427.
     1.88       6.9      11.4      22.0      374.
     2.25       7.2      14.0      30.2      336.
     3.00       7.9      19.6      49.9      286.
     3.75       8.5      25.8      74.2      252.
     4.50       9.2      32.4     103.0      228.
     7.50      15.7      69.7     300.9      168.
    10.50      22.3     126.7     627.3      147.
    13.50      28.8     203.2     1111.      133.
    16.50      35.3     299.5     1779.      122.
    19.50      41.9     415.3     2653.      114.
 END FTABLE180

 FTABLE    150
ROWS COLS ***
  15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.33       3.2       1.1       2.1      366.
     0.67       3.3       2.1       6.6      234.
     1.00       3.3       3.2      13.0      181.
     1.33       3.4       4.3      20.8      151.
     1.67       3.4       5.5      30.0      132.
     2.00       3.5       6.6      40.5      118.
     2.67       3.6       8.9      65.0      100.
     3.33       3.7      11.3      93.6       88.
     4.00       3.8      13.8     126.1       80.
     6.67       6.3      27.3     328.0       60.
     9.33       8.9      47.6     657.0       53.
    12.00      11.5      74.9     1146.       47.
    14.67      14.1     109.1     1824.       43.
    17.33      16.7     150.1     2717.       40.
 END FTABLE150

 FTABLE    130
ROWS COLS ***
  15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.25       2.1       0.5       1.1      324.
     0.50       2.2       1.0       3.6      210.
     0.75       2.3       1.6       7.1      165.
     1.00       2.5       2.2      11.5      139.
     1.25       2.6       2.9      16.8      123.
     1.50       2.7       3.5      23.0      111.
     2.00       3.0       4.9      37.8       95.
     2.50       3.2       6.5      55.9       84.
     3.00       3.5       8.2      77.3       77.
     5.00      12.2      23.9     251.1       69.
     7.00      20.9      57.1     628.1       66.
     9.00      29.7     107.7     1295.       60.
    11.00      38.4     175.7     2326.       55.
    13.00      47.1     261.3     3786.       50.
 END FTABLE130

 FTABLE    120
ROWS COLS ***
  15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
```

```
     0.00       0.0       0.0       0.0        0.
     0.33       2.6       0.8       7.4       83.
     0.67       2.6       1.7      23.4       53.
     1.00       2.6       2.6      45.8       41.
     1.33       2.7       3.5      73.6       34.
     1.67       2.7       4.4     106.2       30.
     2.00       2.8       5.3     143.3       27.
     2.67       2.8       7.2     229.7       23.
     3.33       2.9       9.1     330.9       20.
     4.00       3.0      11.1     445.8       18.
     6.67       5.1      21.8     1160.       14.
     9.33       7.1      38.1     2323.       12.
    12.00       9.2      59.9     4053.       11.
    14.67      11.3      87.3     6449.       10.
    17.33      13.3     120.1     9606.        9.
 END FTABLE120

 FTABLE    100
ROWS COLS ***
  15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.83       3.8       3.1      16.6      135.
     1.67       3.9       6.3      51.7       88.
     2.50       4.0       9.5     100.1       69.
     3.33       4.1      12.9     159.6       59.
     4.17       4.2      16.4     228.9       52.
     5.00       4.4      20.0     307.2       47.
     6.67       4.6      27.5     488.6       41.
     8.33       4.8      35.4     700.8       37.
    10.00       5.1      43.6     942.4       34.
    16.67      12.8     103.4     2697.       28.
    23.33      20.6     214.9     6013.       26.
    30.00      28.4     378.2    11465.       24.
    36.67      36.1     593.1    19538.       22.
    43.33      43.9     859.8    30669.       20.
 END FTABLE100

 FTABLE     90
ROWS COLS ***
  15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.75       3.8       2.8      15.1      134.
     1.50       3.9       5.7      47.7       86.
     2.25       4.1       8.7      93.4       68.
     3.00       4.2      11.8     150.4       57.
     3.75       4.4      15.1     217.8       50.
     4.50       4.5      18.4     294.9       45.
     6.00       4.8      25.5     476.9       39.
     7.50       5.2      33.0     694.3       34.
     9.00       5.5      40.9     946.5       31.
    15.00      11.3      91.1     2682.       25.
    21.00      17.1     176.2     5674.       23.
    27.00      22.9     296.2    10287.       21.
    33.00      28.7     451.1    16830.       19.
    39.00      34.5     640.9    25589.       18.
 END FTABLE 90

 FTABLE     80
ROWS COLS ***
  15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.58       2.8       1.6       4.2      272.
```

```
     1.17       3.0       3.3      13.5      176.
     1.75       3.2       5.1      26.8      138.
     2.33       3.4       7.0      43.6      116.
     2.92       3.5       9.0      64.0      102.
     3.50       3.7      11.1      87.7       92.
     4.67       4.1      15.7     145.2       78.
     5.83       4.5      20.7     216.3       69.
     7.00       4.8      26.1     301.2       63.
    11.67       8.5      57.2     890.1       47.
    16.33      12.1     105.2     1851.       41.
    21.00      15.7     170.0     3261.       38.
    25.67      19.3     251.8     5189.       35.
    30.33      22.9     350.4     7698.       33.
  END FTABLE 80

  FTABLE     30
 ROWS COLS ***
   15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.25       1.0       0.2       0.7      245.
     0.50       1.1       0.5       2.3      162.
     0.75       1.1       0.8       4.4      129.
     1.00       1.2       1.1       7.0      111.
     1.25       1.2       1.4      10.0       99.
     1.50       1.3       1.7      13.5       90.
     2.00       1.4       2.3      21.5       79.
     2.50       1.5       3.0      31.0       71.
     3.00       1.6       3.8      41.9       66.
     5.00       5.4      10.8     137.5       57.
     7.00       9.3      25.5     362.7       51.
     9.00      13.2      48.0     778.0       45.
    11.00      17.1      78.3     1434.       40.
    13.00      20.9     116.3     2376.       36.
  END FTABLE 30

  FTABLE     40
 ROWS COLS ***
   15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.21       3.7       0.8       1.2      477.
     0.42       3.8       1.6       3.7      306.
     0.63       3.9       2.4       7.2      238.
     0.83       4.0       3.2      11.6      200.
     1.04       4.1       4.1      16.8      175.
     1.25       4.2       4.9      22.8      157.
     1.67       4.4       6.7      36.6      133.
     2.08       4.6       8.6      53.1      118.
     2.50       4.8      10.6      72.0      107.
     4.17       9.9      22.9     197.9       84.
     5.83      14.9      43.6     418.4       76.
     7.50      20.0      72.7     763.3       69.
     9.17      25.1     110.3     1258.       64.
    10.83      30.1     156.3     1926.       59.
  END FTABLE 40

  FTABLE     50
 ROWS COLS ***
   15    4
    DEPTH      AREA    VOLUME     DISCH  FLO-THRU ***
     (FT)   (ACRES)   (AC-FT)     (CFS)     (MIN) ***
     0.00       0.0       0.0       0.0        0.
     0.83       7.5       6.1      15.1      296.
     1.67       7.7      12.5      47.8      189.
     2.50       7.9      18.9      93.9      146.
```

```
     3.33       8.1      25.6     151.5      123.
     4.17       8.3      32.4     219.6      107.
     5.00       8.5      39.4     297.6       96.
     6.67       8.9      53.9     481.3       81.
     8.33       9.3      69.0     699.9       72.
    10.00       9.7      84.8     951.9       65.
    16.67      17.8     176.4     2565.       50.
    23.33      25.9     321.9     5205.       45.
    30.00      33.9     521.2     9127.       41.
    36.67      42.0     774.4    14555.       39.
    43.33      50.1    1081.5    21691.       36.
 END FTABLE 50

 FTABLE     20
ROWS COLS ***    Lake Metonga
  13    4
    DEPTH      AREA    VOLUME     DISCH   ***
     (FT)   (ACRES)   (AC-FT)     (CFS)   ***
      0.0        0.        0.       0.0
     39.0     1300.     3050.       0.0
     49.0     1700.    11150.       0.0
     59.0     1800.    22550.       0.0
     69.0     1900.    36750.       0.0
     74.0     1950.    45550.       0.0
     76.5     1980.    49550.       0.0
     79.0     1991.    54550.       0.0
    79.25     2000.    55050.       3.5
    79.50     2005.    55550.       5.5
    79.75     2010.    56050.       9.0
     80.0     2020.    56550.      12.0
     81.0     2050.    58550.      83.0
 END FTABLE 20
    79.50     2005.    55550.       9.5  ***
    79.75     2010.    56050.      18.0  ***
     80.0     2020.    56550.      27.5  ***
     81.0     2050.    58550.      83.0  ***

 FTABLE    210
ROWS COLS ***    Lake Lucerne
  13    4
    DEPTH      AREA    VOLUME     DISCH   ***
     (FT)   (ACRES)   (AC-FT)     (CFS)   ***
      0.0        0.        0.       0.0
     13.0      200.      570.       0.0
     23.0      350.     2500.       0.0
     43.0      650.    10500.       0.0
     53.0      900.    15900.       0.0
     63.0      990.    22500.       0.0
     68.0     1000.    26800.       0.0
     73.0     1005.    31270.       0.0
    73.25     1006.    31500.       3.5
    73.50     1008.    31800.       5.0
    73.75     1011.    32000.      10.0
     74.0     1020.    32300.      15.0
     75.0     1030.    37000.      83.0
     76.0     1100.    35000.     100.0  ***
 END FTABLE210
    73.50     1008.    31800.       9.5  ***
    73.75     1011.    32000.      18.0  ***
     74.0     1020.    32300.      27.5  ***
     75.0     1030.    33300.      83.0  ***


 FTABLE    200
ROWS COLS ***    Ground Hemlock Lake
  11    4
    DEPTH      AREA    VOLUME     DISCH   ***
     (FT)   (ACRES)   (AC-FT)     (CFS)   ***
```

```
       0.0        0.        0.       0.0
      14.0       40.      105.       0.0
      24.0       55.      400.       0.0
      34.0       75.      900.       0.0
      39.0       80.     1200.       0.0
      44.0       85.     1600.       0.0
     44.25       86.     1625.       4.0
     44.50       87.     1645.       7.0
     44.75       88.     1670.      10.0
      45.0       90.     1690.      13.0
      46.0       95.     2000.      50.0
   48.0       100.     2000.  75.0   ***
  END FTABLE200
     44.25       86.     1625.      10.6 ***
     44.50       87.     1645.      30.0 ***
     44.75       88.     1670.      55.2 ***
      45.0       90.     1690.      85.0 ***
      46.0       95.     1780.     250.0 ***

  FTABLE     60
 ROWS COLS ***    Rice Lake
   14    4
     DEPTH      AREA    VOLUME     DISCH   ***
      (FT)   (ACRES)   (AC-FT)     (CFS)   ***
       0.0        0.        0.       0.0
       0.5       25.       7.5       0.0
       1.0       40.       25.       0.0
       1.5       50.       45.       0.0
       2.0       60.       75.       0.0
       2.5       66.      100.       0.0
       3.0       70.      125.       0.0
       3.5       75.      160.       0.0
       4.0      100.      200.       0.0
       4.5      150.      250.      15.0
       5.0      215.      650.      50.0
       6.0      280.      720.     600.0
       7.0      350.     1000.     900.0
       8.0      500.     2000.     1200.
    9.0      650.    2000.     1500.     ***
  END FTABLE 60


END FTABLES

END RUN
```

```
RUN

GLOBAL
  Pickerel Creek - Base Run with modified groundwatershed - 11/03
  START       1955  1  1  0  0  END    1995 12 31 24  0
  RUN INTERP OUTPUT LEVEL    4    0
               RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<type>  <fun>***<------------fname------------------------------------------->
WDM1       41   pick_met.wdm
WDM2       42   pick_out.wdm
MESSU      43   pickerel-base.ech
           91   pickerel-base.per
           92   pickerel-base.imp ***
           93   pickerel-base.rch
END FILES

OPN SEQUENCE
    INGRP              INDELT  1:00
      PERLND     130
      PERLND     230
      PERLND     530
      PERLND     630 ***
      RCHRES     300 ***

      PERLND     133
      PERLND     233 ***
      PERLND     533
      PERLND     633 ***
      RCHRES     330

      PERLND     132
      PERLND     232 ***
      PERLND     532
      PERLND     632 ***
      RCHRES     320

      PERLND     131
      PERLND     231 ***
      PERLND     531
      PERLND     631 ***
      RCHRES     310

      RCHRES     295
      PERLND     129
      PERLND     229
      PERLND     529
      PERLND     629 ***

      PERLND     128
      PERLND     228 ***
      PERLND     528
      PERLND     628 ***
      RCHRES     280 ***
      RCHRES     290

      PERLND     127
      PERLND     227
      PERLND     527
      PERLND     627
      RCHRES     270

      PERLND     125
      PERLND     225
      PERLND     525
      PERLND     625
```

```
      RCHRES     250

      PERLND     126
      PERLND     226
      PERLND     526
      PERLND     626
      RCHRES     260

      COPY       100
      COPY       200
    END INGRP
END OPN SEQUENCE

PERLND

  ACTIVITY
    <PLS >               Active Sections                               ***
    x -  x ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
  125  633    1    1    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
     <PLS> ******************** Print-flags ************************ PIVL  PYR
    x -  x ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC *********
  125  633    5    5    5                                                 1   12
  END PRINT-INFO

  GEN-INFO
    <PLS >      Name                  Unit-systems   Printer***
    x -  x                                t-series Engl Metr***
                                           in  out         ***
  125     Forest (250)                      1    1   91    0
  126     Forest (260)                      1    1   91    0
  127     Forest (270)                      1    1   91    0
  128     Forest (280)                      1    1   91    0
  129     Forest (290)                      1    1   91    0
  130     Forest (300)                      1    1   91    0
  131     Forest (310)                      1    1   91    0
  132     Forest (320)                      1    1   91    0
  133     Forest (330)                      1    1   91    0

  225     Ag/Pasture (250)                  1    1   91    0
  226     Ag/Pasture (260)                  1    1   91    0
  227     Ag/Pasture (270)                  1    1   91    0
  229     Ag/Pasture (290)                  1    1   91    0
  230     Ag/Pasture (300)                  1    1   91    0

  525     Recharge wetland (250)            1    1   91    0
  526     Recharge wetland (260)            1    1   91    0
  527     Recharge wetland (270)            1    1   91    0
  528     Recharge wetland (280)            1    1   91    0
  529     Recharge wetland (290)            1    1   91    0
  530     Recharge Wetland (300)            1    1   91    0
  531     Recharge Wetland (310)            1    1   91    0
  532     Recharge Wetland (320)            1    1   91    0
  533     Recharge Wetland (330)            1    1   91    0

  625     Discharge wetland (250)           1    1   91    0
  626     Discharge wetland (260)           1    1   91    0
  627     Discharge wetland (270)           1    1   91    0
  END GEN-INFO

*** ELDAT = land use elevation - elevation of Laona 6 SW station (1650 ft);
***  Laona 6 SW is documented at 1524.5 ft; topo map suggests ~1650 ft
  ATEMP-DAT
*** <PLS >     ELDAT   AIRTEMP
*** x -  x      (ft)   (deg F)
Forest ***
```

```
  125           -36.      10.0
  126           -45.      10.0
  127           -14.      10.0
  128           -44.      10.0
  129           -27.      10.0
  130            36.      10.0
  131             9.      10.0
  132            18.      10.0
  133           -21.      10.0

Ag/Pasture ***
  225            -8.      10.0
  226           -57.      10.0
  227           -65.      10.0
  229            -4.      10.0
  230             8.      10.0

Recharge wetland ***
  525           -54.      10.0
  526            -6.      10.0
  527           -21.      10.0
  528           -47.      10.0
  529           -48.      10.0
  530            -5.      10.0
  531           -29.      10.0
  532            -3.      10.0
  533           -42.      10.0

Discharge wetland ***
  625          -100.      10.0
  626          -103.      10.0
  627           -97.      10.0
  END ATEMP-DAT

  ICE-FLAG
*** <PLS > Ice
*** x -  x flag
  125  633    1
  END ICE-FLAG

  SNOW-PARM1
*** <PLS >       LAT     MELEV     SHADE    SNOWCF    COVIND
*** x -  x   degrees      (ft)                          (in)
Forest ***
  125           45.5     1614.      0.75      1.25       0.3
  126           45.5     1605.      0.75      1.25       0.3
  127           45.5     1637.      0.75      1.25       0.3
  128           45.5     1606.      0.75      1.25       0.3
  129           45.5     1623.      0.75      1.25       0.3
  130           45.5     1686.      0.75      1.25       0.3
  131           45.5     1659.      0.75      1.25       0.3
  132           45.5     1668.      0.75      1.25       0.3
  133           45.5     1629.      0.75      1.25       0.3

Ag/Pasture ***
  225           45.5     1642.      0.40      1.25       0.3
  226           45.5     1594.      0.40      1.25       0.3
  227           45.5     1585.      0.40      1.25       0.3
  229           45.5     1646.      0.40      1.25       0.3
  230           45.5     1658.      0.40      1.25       0.3

Recharge wetland ***
  525           45.5     1596.      0.70      1.25       0.3
  526           45.5     1644.      0.70      1.25       0.3
  527           45.5     1629.      0.70      1.25       0.3
  528           45.5     1603.      0.70      1.25       0.3
  529           45.5     1602.      0.70      1.25       0.3
  530           45.5     1645.      0.70      1.25       0.3
```

```
  531           45.5     1621.      0.70      1.25       0.3
  532           45.5     1647.      0.70      1.25       0.3
  533           45.5     1608.      0.70      1.25       0.3

Discharge wetland ***
  625           45.5     1550.      0.70      1.25       0.3
  626           45.5     1547.      0.70      1.25       0.3
  627           45.5     1553.      0.70      1.25       0.3
  END SNOW-PARM1

  SNOW-PARM2
*** <PLS >     RDCSN     TSNOW    SNOEVP    CCFACT    MWATER    MGMELT
*** x -  x             (deg F)                                (in/day)
  125  633       0.1      30.0      0.05    0.0005      0.24      .023
  END SNOW-PARM2

  SNOW-INIT1
*** <PLS > Pack-snow  Pack-ice Pack-watr    RDENPF      DULL    PAKTMP
*** x -  x      (in)      (in)      (in)                       (deg F)
  125  633       2.0       0.0      0.15       0.2     375.0      32.0
  END SNOW-INIT1

  SNOW-INIT2
*** <PLS >    COVINX    XLNMLT    SKYCLR
*** x -  x      (in)      (in)
  125  633      0.01       0.0       1.0
  END SNOW-INIT2

  PWAT-PARM1
*** <PLS >                    Flags
*** x -  x CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE IFFC  HWT
  125  133    1    1    1    1    1    0    0    0    1         0
  225  233    1    1    1    1    1    0    0    0    1         0
  525  533    1    3    1    1    0    0    0    0    1         1
  625  633    1    3    1    1    0    0    0    0    1         1
  END PWAT-PARM1

  PWAT-PARM2
***  <PLS>    FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
*** x -  x                (in)   (in/hr)      (ft)              (1/in)   (1/day)
Forest ***
  125            .75      6.35     0.065     300.0     0.067     0.000     0.975
  126            .75      6.35     0.065     300.0     0.046     0.000     0.975
  127            .75      6.35     0.065     300.0     0.067     0.000     0.975
  128            .75      6.35     0.065     300.0     0.047     0.000     0.975
  129            .75      6.35     0.065     300.0     0.059     0.000     0.975
  130            .75      6.35     0.065     300.0     0.064     0.000     0.975
  131            .75      6.35     0.065     300.0     0.047     0.000     0.975
  132            .75      6.35     0.065     300.0     0.052     0.000     0.975
  133            .75      6.35     0.065     300.0     0.065     0.000     0.975

Ag/Pasture ***
  225            0.0      6.35     0.065     250.0     0.091     0.000     0.975
  226            0.0      6.35     0.065     300.0     0.039     0.000     0.975
  227            0.0      6.35     0.065     250.0     0.074     0.000     0.975
  229            0.0      6.35     0.065     200.0     0.120     0.000     0.975
  230            0.0      6.35     0.065     200.0     0.110     0.000     0.975

Recharge wetland ***
  525           0.45      6.15     0.037      50.0     0.021     0.000     0.985
  526           0.45      6.15     0.037      50.0     0.017     0.000     0.985
  527           0.45      6.15     0.037      50.0     0.013     0.000     0.985
  528           0.45      6.15     0.037      50.0     0.005     0.000     0.985
  529           0.45      6.15     0.037      50.0     0.007     0.000     0.985
  530           0.45      6.15     0.037      50.0     0.010     0.000     0.985
  531           0.45      6.15     0.037      50.0     0.005     0.000     0.985
  532           0.45      6.15     0.037      50.0     0.009     0.000     0.985
  533           0.45      6.15     0.037      50.0     0.015     0.000     0.985
```

```
Discharge wetland ***
  625          0.45      6.15     0.037      50.0     0.013     0.000     0.985
  626          0.45      6.15     0.037      50.0     0.022     0.000     0.985
  627          0.45      6.15     0.037      50.0     0.025     0.000     0.985
  END PWAT-PARM2
                                                     `

  PWAT-PARM3
***  <PLS>    PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
*** x -  x   (deg F)   (deg F)
  125  133      34.5      28.0       2.0       2.0     0.025     0.000     0.000
  225  233      34.5      28.0       2.0       2.0     0.030     0.000     0.000
  525  533      34.5      28.0       2.0       2.0     0.030     0.000     0.000
  625  633      34.5      28.0       2.0       2.0     0.030     0.000     0.000
  END PWAT-PARM3

  PWAT-PARM4
*** <PLS >     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP
*** x -  x      (in)      (in)                       (1/day)
  125  133     0.000      0.55      0.25     0.900      0.30       0.7
  225  233     0.000      0.75      0.15     1.275      0.45       0.7
  525  533     0.000      0.55      0.05     0.475      0.45       0.6
  625  633     0.000      0.55      0.05     0.475      0.45       0.6
  END PWAT-PARM4

  PWAT-PARM6
***  <PLS>     MELEV      BELV    GWDATM       PCW       PGW      UPGW
*** x -  x      (ft)      (ft)      (ft)       (-)       (-)       (-)
  525          1596.     1594.     1576.      0.29      0.31      0.31
  526          1644.     1642.     1624.      0.24      0.33      0.33
  527          1629.     1627.     1609.      0.21      0.32      0.32
  528          1603.     1601.     1583.      0.25      0.33      0.33
  529          1602.     1600.     1582.      0.21      0.39      0.39
  530          1645.     1643.     1625.      0.22      0.31      0.31
  531          1621.     1619.     1601.      0.26      0.30      0.30
  532          1647.     1645.     1627.      0.23      0.32      0.32
  533          1608.     1606.     1588.      0.19      0.29      0.29

  625          1550.     1548.     1530.      0.29      0.31      0.31
  626          1547.     1545.     1527.      0.24      0.33      0.33
  627          1554.     1552.     1534.      0.21      0.32      0.32
  END PWAT-PARM6

  PWAT-PARM7
***  <PLS>    STABNO      SRRC     SREXP     IFWSC     DELTA    UELFAC    LELFAC
*** x -  x         -     (/hr)       (-)      (in)      (in)       (-)       (-)
  525  633         1       0.5      1.00       1.0
  END PWAT-PARM7

  MON-INTERCEP
*** <PLS >  Interception storage capacity at start of each month (in)
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  125  133 0.02 0.02 0.05 0.07 0.09 0.10 0.10 0.10 0.08 0.08 0.06 0.02
  225  233 0.01 0.01 0.02 0.02 0.02 0.02 0.08 0.08 0.06 0.03 0.01 0.01
  525  533 0.01 0.01 0.02 0.02 0.02 0.02 0.08 0.08 0.06 0.03 0.01 0.01
  625  633 0.01 0.01 0.02 0.02 0.02 0.02 0.08 0.08 0.06 0.03 0.01 0.01
  END MON-INTERCEP

  MON-UZSN
*** <PLS >  Upper zone storage at start of each month  (inches)
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  125  133 1.15 1.15 0.75 0.50 0.50 0.25 0.05 0.10 0.25 0.50 1.25 1.20
  225  233  0.8  0.8 0.85 0.85  0.9  0.1  0.1 0.15  0.3 0.60 0.90  0.9
  END MON-UZSN

  MON-LZETPARM
*** <PLS >  Lower zone evapotranspiration parm. at start of each month
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
```

```
  125  133 0.30 0.30 0.35 0.40 0.42 0.43 0.43 0.45 0.40 0.35 0.30 0.30
  225  233 0.20 0.25 0.30 0.30 0.35 0.35 0.35 0.35 0.30 0.30 0.25 0.15
  525  533 0.20 0.25 0.30 0.30 0.35 0.35 0.35 0.35 0.30 0.30 0.25 0.15
  625  633 0.20 0.25 0.30 0.30 0.35 0.35 0.35 0.35 0.30 0.30 0.25 0.15
  END MON-LZETPARM

  PWAT-STATE1
***  <PLS>  PWATER state variables (in)
*** x -  x      CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
  125  133       0.0       0.0       1.0       0.0      7.50      0.40       0.0
  225  233       0.0       0.0      1.15       0.0      7.50      0.40       0.0
  525  533       0.0       0.2      2.25       1.0     15.30      2.35       0.0
  625  633       0.0       0.2      2.25       1.0     15.30      0.45       0.0
  END PWAT-STATE1
END PERLND

IMPLND

  ACTIVITY
*** <ILS >               Active Sections
*** x -  x ATMP SNOW IWAT  SLD  IWG IQAL
  325  333    1    1    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    x -  x ATMP SNOW IWAT  SLD  IWG IQAL *********
  325  333    5    5    5                   1   12
  END PRINT-INFO

  GEN-INFO
*** <ILS >      Name             Unit-systems   Printer
*** <ILS >                           t-series Engl Metr
*** x -  x                            in  out
  325  333Urban-Impervious             1    1   92    0
  END GEN-INFO

  ATEMP-DAT
*** <ILS >     ELDAT   AIRTEMP
*** x -  x      (ft)   (deg F)
  302           -28.      10.0
  END ATEMP-DAT

  ICE-FLAG
*** <ILS > Ice
*** x -  x flag
  325  333    1
  END ICE-FLAG

  SNOW-PARM1
*** <ILS >       LAT     MELEV     SHADE    SNOWCF    COVIND
*** x -  x   degrees      (ft)                          (in)
  302           45.5     1622.       0.1      1.25       0.3
  END SNOW-PARM1

  SNOW-PARM2
*** <ILS >     RDCSN     TSNOW    SNOEVP    CCFACT    MWATER    MGMELT
*** x -  x             (deg F)                                (in/day)
  302            0.1      30.0      0.05     0.004      0.24      .023
  END SNOW-PARM2

  SNOW-INIT1
*** <ILS > Pack-snow  Pack-ice Pack-watr    RDENPF      DULL    PAKTMP
*** x -  x      (in)      (in)      (in)                        (deg F)
  302            1.5       0.0      0.15       0.2     375.0      32.0
  END SNOW-INIT1

  SNOW-INIT2
```

```
*** <ILS >    COVINX    XLNMLT    SKYCLR
*** x -  x      (in)      (in)
  302           0.01       0.0       1.0
  END SNOW-INIT2

  IWAT-PARM1
*** <ILS >        Flags
*** x -  x CSNO RTOP  VRS  VNN RTLI
  302         1    1    1    0    0
  END IWAT-PARM1

  IWAT-PARM2
*** <ILS >      LSUR     SLSUR      NSUR     RETSC
*** x -  x      (ft)                          (ft)
  302          300.0     0.010       0.1       0.0
  END IWAT-PARM2

  MON-RETN
*** <ILS >  Retention storage capacity at start of each month (in)
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  302      .036 .036 .049 .049 .049 .065 .065 .065 .049 .049 .049 .036
  END MON-RETN

  IWAT-STATE1
*** <ILS >  IWATER state variables (inches)
*** x -  x      RETS      SURS
  302          0.001     0.001
  END IWAT-STATE1

END IMPLND

RCHRES

  ACTIVITY
*** RCHRES  Active sections
*** x -  x HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG
  250  330    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
*** RCHRES  Printout level flags
*** x -  x HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR
  250  330    5                                                1   12
  END PRINT-INFO

  GEN-INFO
***              Name        Nexits   Unit Systems   Printer
*** RCHRES<------------------><--->      t-series  Engl Metr LKFG
*** x -  x                                in  out
  250     Upper Pickerel Creek    1         1    1   93    0    0
  260     Rolling Stone Lake      1         1    1   93    0    1
  270     Below Beaver Dam        1         1    1   93    0    0
  290     Little Sand Lake        2         1    1   93    0    1
  295     Inlet to Little Sand    1         1    1   93    0    0
  310     Duck Lake               2         1    1   93    0    1
  320     Deep Hole Lake          2         1    1   93    0    1
  330     Skunk Lake              2         1    1   93    0    1
  END GEN-INFO

  HYDR-PARM1
***         Flags for HYDR section
    RCHRES  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
    x -  x  FG FG FG FG  possible   exit *** possible   exit     possible   exit
  250        0  1  1  1    4
  260        0  1  1  1    4
  270        0  1  1  1    4
  290        0  1  1  1    5  4
  295        0  1  1  1    4
```

```
  310        0  1  1  1    5  4
  320        0  1  1  1    5  4
  330        0  1  1  1    5  4
  END HYDR-PARM1

  HYDR-PARM2
*** RCHRES    FTABNO       LEN     DELTH     STCOR        KS      DB50
*** x -  x             (miles)      (ft)      (ft)                (in)
  250            250       1.8      24.0       0.0       0.5      0.01
  260            260       2.0       0.0    1523.0       0.5      0.01
  270            270       1.1      45.0       0.0       0.5      0.01
  290            290       0.9       0.0    1573.0       0.5      0.01
  295            295       0.8       5.0       0.0       0.5      0.01
  310            310       0.2       0.0    1601.1       0.5      0.01
  320            320       0.5       0.0    1594.8       0.5      0.01
  330            330       0.1       0.0    1594.1       0.5      0.01
  END HYDR-PARM2

  HYDR-INIT
***         Initial conditions for HYDR section
*** RCHRES       VOL  CAT Initial value  of COLIND     initial  value  of OUTDGT
*** x -  x     ac-ft      for each possible   exit  for each possible exit,ft3
  250            2.0
  260         4800.0
  270            1.0
  290         2100.0
  295            0.6
  310          120.0
  320          670.0
  330            4.0
  END HYDR-INIT

END RCHRES

COPY
  TIMESERIES
  Copy-opn***
*** x -  x  NPT  NMN
  100         0   12
  200         0    1
  END TIMESERIES
END COPY

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   x <Name> x tem strg<-factor->strg <Name>   x   x        <Name> x x  ***

Meteorologic data                                                  ***

WDM1  3022 PRCP  31 ENGLZERO              PERLND 125 633 EXTNL  PREC   1 1
WDM1  3026 TEMP  31 ENGL             SAME PERLND 125 633 EXTNL  GATMP  1 1
WDM1  3001 TEMP  31 ENGL             SAME PERLND 125 633 EXTNL  DTMPG  1 1
WDM1  2041 CLDC  31 ENGL             SAME PERLND 125 633 EXTNL  CLOUD  1 1
WDM1  3021 WIND  31 ENGL                  PERLND 125 633 EXTNL  WINMOV 1 1
WDM1  2043 SOLR  31 ENGL             SAME PERLND 125 633 EXTNL  SOLRAD 1 1
WDM1  3017 EVAP  31 ENGL         1.00     PERLND 125 333 EXTNL  PETINP 1 1
WDM1  3017 EVAP  31 ENGL         0.80     PERLND 525 633 EXTNL  PETINP 1 1



WDM1  3022 PRCP  31 ENGLZERO              IMPLND 325 333 EXTNL  PREC   1 1
WDM1  3026 TEMP  31 ENGL             SAME IMPLND 325 333 EXTNL  GATMP  1 1
WDM1  3001 TEMP  31 ENGL             SAME IMPLND 325 333 EXTNL  DTMPG  1 1
WDM1  2041 CLDC  31 ENGL             SAME IMPLND 325 333 EXTNL  CLOUD  1 1
WDM1  3021 WIND  31 ENGL                  IMPLND 325 333 EXTNL  WINMOV 1 1
WDM1  2043 SOLR  31 ENGL             SAME IMPLND 325 333 EXTNL  SOLRAD 1 1
WDM1  3017 EVAP  31 ENGL         1.0      IMPLND 325 333 EXTNL  PETINP 1 1

WDM1  3022 PRCP  31 ENGLZERO              RCHRES 250 330 EXTNL  PREC   1 1
```

```
WDM1  3017 EVAP  31 ENGL         1.0       RCHRES 250 330 EXTNL  POTEV  1 1
END EXT SOURCES

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
*** generate groundwater levels for wetlands
*** this is computed below as GWEL (ft) + SURS (in) /12
PERLND 525 PWATER GWEL                AVER COPY   100     INPUT  MEAN   1
PERLND 525 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN   1
PERLND 526 PWATER GWEL                AVER COPY   100     INPUT  MEAN   2
PERLND 526 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN   2
PERLND 527 PWATER GWEL                AVER COPY   100     INPUT  MEAN   3
PERLND 527 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN   3
PERLND 528 PWATER GWEL                AVER COPY   100     INPUT  MEAN   4
PERLND 528 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN   4
PERLND 529 PWATER GWEL                AVER COPY   100     INPUT  MEAN   5
PERLND 529 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN   5
PERLND 530 PWATER GWEL                AVER COPY   100     INPUT  MEAN   6
PERLND 530 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN   6
PERLND 531 PWATER GWEL                AVER COPY   100     INPUT  MEAN   7
PERLND 531 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN   7
PERLND 532 PWATER GWEL                AVER COPY   100     INPUT  MEAN   8
PERLND 532 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN   8
PERLND 533 PWATER GWEL                AVER COPY   100     INPUT  MEAN   9
PERLND 533 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN   9

PERLND 625 PWATER GWEL                AVER COPY   100     INPUT  MEAN  10
PERLND 625 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN  10
PERLND 626 PWATER GWEL                AVER COPY   100     INPUT  MEAN  11
PERLND 626 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN  11
PERLND 627 PWATER GWEL                AVER COPY   100     INPUT  MEAN  12
PERLND 627 PWATER SURS        0.0833  AVER COPY   100     INPUT  MEAN  12
END NETWORK

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Aggr Amd ***
<Name>   x        <Name> x x<-factor->strg <Name>   x <Name>qf  tem strg strg***

  Flow rates ***
RCHRES 250 HYDR   RO     1 1          AVER WDM2   601 FLOW   0 ENGL AGGR REPL
RCHRES 260 HYDR   RO     1 1          AVER WDM2   602 FLOW   0 ENGL AGGR REPL
RCHRES 270 HYDR   RO     1 1          AVER WDM2   603 FLOW   0 ENGL AGGR REPL
RCHRES 290 HYDR   O      2 1          AVER WDM2   605 FLOW   0 ENGL AGGR REPL
RCHRES 295 HYDR   RO     1 1          AVER WDM2   606 FLOW   0 ENGL AGGR REPL
RCHRES 310 HYDR   O      2 1          AVER WDM2   608 FLOW   0 ENGL AGGR REPL
RCHRES 320 HYDR   O      2 1          AVER WDM2   609 FLOW   0 ENGL AGGR REPL
RCHRES 330 HYDR   O      2 1          AVER WDM2   610 FLOW   0 ENGL AGGR REPL
RCHRES 290 HYDR   O      1 1          AVER WDM2   616 SEEP   0 ENGL AGGR REPL
RCHRES 310 HYDR   O      1 1          AVER WDM2   617 SEEP   0 ENGL AGGR REPL
RCHRES 320 HYDR   O      1 1          AVER WDM2   618 SEEP   0 ENGL AGGR REPL
RCHRES 330 HYDR   O      1 1          AVER WDM2   619 SEEP   0 ENGL AGGR REPL

  Lake depths  ***
RCHRES 260 HYDR   STAGE  1 1          AVER WDM2   611 STGE   0 ENGL AGGR REPL
RCHRES 290 HYDR   STAGE  1 1          AVER WDM2   612 STGE   0 ENGL AGGR REPL
RCHRES 310 HYDR   STAGE  1 1          AVER WDM2   613 STGE   0 ENGL AGGR REPL
RCHRES 320 HYDR   STAGE  1 1          AVER WDM2   614 STGE   0 ENGL AGGR REPL
RCHRES 330 HYDR   STAGE  1 1          AVER WDM2   615 STGE   0 ENGL AGGR REPL

  Snow Depth (total land area = 8353 acres)  ***


COPY   200 OUTPUT MEAN   1 1  1.197E-4AVER WDM2   621 SNOW   0 ENGL AGGR REPL

Hourly Wetland GW Elevations (= GWEL + SURS)  ***
COPY   100 OUTPUT MEAN   1 1          SAME WDM2   701 GWEL   1 ENGL      REPL
COPY   100 OUTPUT MEAN   2 1          SAME WDM2   702 GWEL   1 ENGL      REPL
COPY   100 OUTPUT MEAN   3 1          SAME WDM2   703 GWEL   1 ENGL      REPL
```

```
COPY   100 OUTPUT MEAN   4 1          SAME WDM2   704 GWEL   1 ENGL      REPL
COPY   100 OUTPUT MEAN   5 1          SAME WDM2   705 GWEL   1 ENGL      REPL
COPY   100 OUTPUT MEAN   6 1          SAME WDM2   706 GWEL   1 ENGL      REPL
COPY   100 OUTPUT MEAN   7 1          SAME WDM2   707 GWEL   1 ENGL      REPL
COPY   100 OUTPUT MEAN   8 1          SAME WDM2   708 GWEL   1 ENGL      REPL
COPY   100 OUTPUT MEAN   9 1          SAME WDM2   709 GWEL   1 ENGL      REPL
COPY   100 OUTPUT MEAN  10 1          SAME WDM2   710 GWEL   1 ENGL      REPL
COPY   100 OUTPUT MEAN  11 1          SAME WDM2   711 GWEL   1 ENGL      REPL
COPY   100 OUTPUT MEAN  12 1          SAME WDM2   712 GWEL   1 ENGL      REPL
END EXT TARGETS

SCHEMATIC
<-Volume->                  <--Area-->  <-Volume->     <ML#>         ***
<Name>  x                   <-factor->      <Name> x                 ***

Tributary areas                                                      ***

Segment  250                                                         ***
*** assume removed AGWO contribution area (300.5 acres) is in
*** proportion to existing land types and is only in "direct to stream"

non-wetland to recharge wetland                                      ***
               Forest ratio:  46.1/  17.2                            ***
                   Ag ratio:   3.9/  17.2                            ***
PERLND 125                    2.68      PERLND 525      4
PERLND 225                    0.227     PERLND 525      4

non-wetland to discharge wetland                                     ***
               Forest ratio: 449.7/ 627.2                            ***
                   Ag ratio:   8.5/ 627.2                            ***
PERLND 125                    0.717     PERLND 625      4
PERLND 225                    0.014     PERLND 625      4

to stream                                                            ***
PERLND 125                   310.1      RCHRES 250      1
PERLND 125                   179.5      RCHRES 250      8
PERLND 225                     4.0      RCHRES 250      1
PERLND 225                     3.7      RCHRES 250      8
PERLND 525                    14.1      RCHRES 250      1
PERLND 525                     3.1      RCHRES 250      8
PERLND 625                   513.0      RCHRES 250      1
PERLND 625                   114.2      RCHRES 250      8

Segment  260                                                         ***
*** assume removed AGWO contribution area (431.7 acres) and
*** added AGWO area from outside all segments is in
*** proportion to existing land types and is only in "direct to stream"
*** handle added AGWO area (109.5 acres and 17.3 acres) from
*** segments 80 and 110 separately

non-wetland to recharge wetland                                      ***
               Forest ratio: 256.0/  63.8                            ***
                   Ag ratio:   1.8/  63.8                            ***
PERLND 126                    4.013     PERLND 526      4
PERLND 226                    0.028     PERLND 526      4

non-wetland to discharge wetland                                     ***
               Forest ratio: 527.9/ 637.0                            ***
                   Ag ratio:  13.7/ 637.0                            ***
PERLND 126                    0.829     PERLND 626      4
PERLND 226                    0.022     PERLND 626      4

to stream                                                            ***
PERLND 126                  1237.1      RCHRES 260      1
PERLND 226                    12.7      RCHRES 260      1
PERLND 526                    63.8      RCHRES 260      1
PERLND 626                   637.0      RCHRES 260      1
```

```
*** net area (added from outside watershed - removed area)
PERLND 126                    246.8      RCHRES 260      9
PERLND 226                      3.4      RCHRES 260      9
PERLND 526                      7.8      RCHRES 260      9
PERLND 626                     77.8      RCHRES 260      9

*** area of gwshed from segment 80
PERLND 126                     74.8      RCHRES 260      9
PERLND 226                     14.6      RCHRES 260      9
PERLND 526                      8.3      RCHRES 260      9
PERLND 626                     11.7      RCHRES 260      9

*** area of gwshed from segment 110
PERLND 126                     17.3      RCHRES 260      9

Segment  270                                                          ***

non-wetland to recharge wetland                                       ***
              Forest ratio: 220.9/ 110.9                              ***
                  Ag ratio:   0.2/ 110.9                              ***
PERLND 127                     1.992     PERLND 527      4
PERLND 227                     0.002     PERLND 527      4

non-wetland to discharge wetland                                      ***
              Forest ratio: 208.9/ 221.4                              ***
                  Ag ratio:   3.3/ 221.4                              ***
PERLND 127                     0.944     PERLND 627      4
PERLND 227                     0.015     PERLND 627      4

*** remove 16.4 acres of gwshed (AGWO) from forest to stream
to stream                                                             ***
PERLND 127                     16.4      RCHRES 270      8
PERLND 127                    551.7      RCHRES 270      1
PERLND 227                      6.1      RCHRES 270      1
PERLND 527                    110.9      RCHRES 270      1
PERLND 627                    221.4      RCHRES 270      1

Segment  280   above beaver dam which controls Little Sand Lake     ***
               assume area drains to Little Sand Lake                 ***
               Little Sand Lake outlet control imposed on RCHRES 290***

non-wetland to recharge wetland                                       ***
              Forest ratio:  27.3/  38.7                              ***
PERLND 128                     0.705     PERLND 528      4

to stream                                                             ***
PERLND 128                     65.0      RCHRES 290      1
PERLND 528                     38.7      RCHRES 290      1

Segment  290                                                          ***
*** assume removed AGWO contribution area (442.0 - 226.8 = 215.2 acres)
*** is in proportion to existing land types and is distributed to
*** all categories

non-wetland to recharge wetland                                       ***
         total Forest ratio: 272.1/ 135.1                             ***
        "PERO" Forest ratio: 198.0/ 135.1                             ***
      "noAGWO" Forest ratio:  74.1/ 135.1                             ***
         total     Ag ratio:   6.7/ 135.1                             ***
        "PERO"     Ag ratio:   4.9/ 135.1                             ***
      "noAGWO"     Ag ratio:   1.8/ 135.1                             ***
PERLND 129                     1.466     PERLND 529      4
PERLND 129                     0.548     PERLND 529     10
PERLND 229                     0.036     PERLND 529      4
PERLND 229                     0.014     PERLND 529     10

to stream                                                             ***
PERLND 129                    265.4      RCHRES 290      1
```

```
PERLND 129                      99.4      RCHRES 290      8
PERLND 229                       8.1      RCHRES 290      1
PERLND 229                       3.1      RCHRES 290      8
PERLND 529                      98.3      RCHRES 290      1
PERLND 529                      36.8      RCHRES 290      8

Segment  300  Burr Oak Swamp - no reach                             ***
*** assume gwshed changes have no impact since this segment does not
*** contribute runoff to streams/lakes

non-wetland to recharge wetland                                     ***
               Forest ratio:  87.8/  50.9                           ***
PERLND 130                      1.725     PERLND 530      4

to stream                                                           ***
PERLND 130       ***           112.3      RCHRES 330      1
PERLND 230       ***             2.1      RCHRES 330      1
PERLND 530       ***            50.9      RCHRES 330      1

Segment  310                                                        ***
*** assume removed AGWO contribution area (262.4 - 26.8 = 235.6 acres)
*** is in proportion to existing land types and is distributed to
*** all categories

non-wetland to recharge wetland                                     ***
         total Forest ratio: 179.4/  72.9                           ***
        "PERO" Forest ratio:  64.7/  72.9                           ***
      "noAGWO" Forest ratio: 114.7/  72.9                           ***

PERLND 131                      0.888     PERLND 531      4
PERLND 131                      1.573     PERLND 531     10

to stream                                                           ***
PERLND 131                      41.9      RCHRES 310      1
PERLND 131                      74.2      RCHRES 310      8
PERLND 531                      26.3      RCHRES 310      1
PERLND 531                      46.6      RCHRES 310      8

Segment  320                                                        ***

non-wetland to recharge wetland                                     ***
         total Forest ratio: 348.8/ 138.9                           ***
        "PERO" Forest ratio: 207.5/ 138.9                           ***
      "noAGWO" Forest ratio: 141.3/ 138.9                           ***

PERLND 132                      1.494     PERLND 532      4
PERLND 132                      1.017     PERLND 532     10

to stream                                                           ***
PERLND 132                     271.8      RCHRES 320      1
PERLND 132                     185.0      RCHRES 320      8
PERLND 532                      82.7      RCHRES 320      1
PERLND 532                      56.2      RCHRES 320      8

Segment  330                                                        ***
*** all gwshed removed - change MASS-LINK transfers from PERO to SURO+IFWO

non-wetland to recharge wetland                                     ***
               Forest ratio:  26.6/   9.1                           ***
PERLND 133                      2.923     PERLND 533     10

to stream                                                           ***
PERLND 133                      88.2      RCHRES 330      8
PERLND 533                       9.1      RCHRES 330      8

Reach Connections                                                   ***
RCHRES 330                                RCHRES 290      7
RCHRES 310                                RCHRES 295      7
```

```
RCHRES 320                                 RCHRES 295      7
RCHRES 295                                 RCHRES 290      3
RCHRES 290                                 RCHRES 270      7
RCHRES 270                                 RCHRES 260      3
RCHRES 250                                 RCHRES 260      3

areal average snow depth computation ***
PERLND 125                      985.4     COPY   200      6
PERLND 225                       20.1     COPY   200      6
PERLND 525                       17.2     COPY   200      6
PERLND 625                      627.2     COPY   200      6

PERLND 126                     2021.0     COPY   200      6
PERLND 226                       28.2     COPY   200      6
PERLND 526                       63.8     COPY   200      6
PERLND 626                      637.0     COPY   200      6

PERLND 127                      997.9     COPY   200      6
PERLND 227                        9.6     COPY   200      6
PERLND 527                      110.9     COPY   200      6
PERLND 627                      221.4     COPY   200      6

PERLND 128                       92.3     COPY   200      6
PERLND 528                       38.7     COPY   200      6

PERLND 129                      639.0     COPY   200      6
PERLND 229                       17.9     COPY   200      6
PERLND 529                      135.1     COPY   200      6

PERLND 130                      200.1     COPY   200      6
PERLND 230                        2.1     COPY   200      6
PERLND 530                       50.9     COPY   200      6

PERLND 131                      295.5     COPY   200      6
PERLND 531                       72.9     COPY   200      6

PERLND 132                      805.6     COPY   200      6
PERLND 532                      138.9     COPY   200      6

PERLND 133                      114.8     COPY   200      6
PERLND 533                        9.1     COPY   200      6

END SCHEMATIC

MASS-LINK

  MASS-LINK        1
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Conversion of Runoff from inches to ac-ft = 0.083333***
PERLND     PWATER PERO       0.0833333     RCHRES         INFLOW IVOL
  END MASS-LINK    1

  MASS-LINK        2
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Conversion of Runoff from inches to ac-ft = 0.083333***
IMPLND     IWATER SURO       0.0833333     RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Reach Transfer of FLOW ***
RCHRES     ROFLOW                          RCHRES         INFLOW
  END MASS-LINK    3

  MASS-LINK        7
```

```
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Reach Transfer of FLOW ***
RCHRES     OFLOW  OVOL   2                 RCHRES         INFLOW IVOL
  END MASS-LINK    7

  MASS-LINK        4
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Lateral flows of water - assume upland IFWO goes to groundwater in wetland
PERLND     PWATER SURO                     PERLND         EXTNL  SURLI
PERLND     PWATER IFWO                     PERLND         EXTNL  SURLI
PERLND     PWATER AGWO                     PERLND         EXTNL  SURLI
  END MASS-LINK    4

  MASS-LINK        5
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
IMPLND     IWATER SURO                     PERLND         EXTNL  SURLI
  END MASS-LINK    5

  MASS-LINK        6
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
PERLND     SNOW   PDEPTH                   COPY           INPUT  MEAN   1 0
  END MASS-LINK    6

  MASS-LINK        8
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
PERLND     PWATER SURO       0.0833333     RCHRES         INFLOW IVOL
PERLND     PWATER IFWO       0.0833333     RCHRES         INFLOW IVOL
  END MASS-LINK    8

  MASS-LINK        9
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
PERLND     PWATER AGWO       0.0833333     RCHRES         INFLOW IVOL
  END MASS-LINK    9

  MASS-LINK       10
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> x x<-factor->strg <Name>                <Name> x x  ***
***Lateral flows of water - assume upland IFWO goes to groundwater in wetland
PERLND     PWATER SURO                     PERLND         EXTNL  SURLI
PERLND     PWATER IFWO                     PERLND         EXTNL  SURLI
  END MASS-LINK   10

END MASS-LINK

FTABLES
  FTABLE      1
 ROWS COLS ***
    7    2
     DEPTH      FRAC ***
      (IN)           ***
       0.0      0.00
       2.0      0.00
       3.0      0.00
       4.0      0.01
       6.0      0.06
      12.0      0.20
      24.0      0.50
  END FTABLE  1

  FTABLE    250               Upper Pickerel Creek
 ROWS COLS ***
   13    4
```

```
    DEPTH      AREA    VOLUME     DISCH  ***
     (FT)   (ACRES)   (AC-FT)     (CFS)  ***
     0.00       0.0       0.0       0.0
     0.13       3.1       0.4       0.0
     0.25       3.1       0.8       0.0
     0.38       3.1       1.2       0.0
     0.50       3.1       1.5       0.0
     0.63       3.1       1.9       0.0
     0.75       3.2       2.3       0.0
     1.00       3.2       3.1       1.0
     1.25       3.2       3.9       2.0
     1.50       3.3       4.7       4.0
     2.50       7.6      10.2       8.0
     3.50      12.0      20.0      50.0
     4.50      16.4      60.0     250.0
  END FTABLE250

  FTABLE    260                  Rolling Stone Lake
 ROWS COLS ***                    weir calc.
   15    4
    DEPTH      AREA    VOLUME      FLOW ***
     (ft)      (ac)   (ac-ft)     (cfs) ***
      0.0        0.        0.       0.0
      2.0      280.      150.       0.0
      4.0      310.      650.       0.0
      6.0      400.     1200.       0.0
      8.0      500.     1850.       0.0
      9.0      550.     2400.       0.0
     10.0      600.     3000.       0.0
     11.0      640.     4000.       0.0
     12.0      670.     4800.       0.0
     12.1      670.     4860.       5.0
     12.2      672.     4920.      14.0
     12.4      674.     5060.      41.0
     12.6      676.     5200.      77.0
     12.8      678.     5340.     125.0
     14.0      700.     6100.     300.0
  END FTABLE260

  FTABLE    270
 ROWS COLS ***
   13    4
    DEPTH      AREA    VOLUME     DISCH  ***
     (FT)   (ACRES)   (AC-FT)     (CFS)  ***
     0.00       0.0       0.0       0.0
     0.33       1.4       0.4       0.0
     0.67       1.4       0.9       0.0
     1.00       1.4       1.4       1.0
     1.33       1.4       1.8       2.0
     1.67       1.4       2.3       3.0
     2.00       1.5       2.8       4.0
     2.67       1.5       3.8       6.0
     3.33       1.6       4.8      20.0
     4.00       1.6       5.9     100.0
     6.67       8.0      40.0     400.0
     7.33      12.0      60.0     800.0
    12.00      16.0     100.0    1400.0
  END FTABLE270

  FTABLE    290                  Little Sand Lake
 ROWS COLS ***                   STCOR = 1573.0
   20    5
    DEPTH      AREA    VOLUME      FLOW   SEEPAGE***
     (ft)      (ac)   (ac-ft)     (cfs)     (cfs)***
      0.0       0.0       0.0       0.0       0.0
      3.0       0.6       0.6       0.0    0.0000
      6.0      18.6      18.6       0.0     0.001
      7.0      24.7      40.5       0.0     0.001
```

```
      8.0      31.9      68.3       0.0     0.002
      9.0      40.5     105.0       0.0     0.002
     10.0      50.0     149.4       0.0     0.003
     11.0      96.9     238.2       0.0     0.007
     12.0     115.3     342.5       0.0     0.009
     13.0     135.3     469.9       0.0     0.011
     14.0     155.7     613.0       0.0     0.014
     15.0     177.5     781.3       0.0     0.017
     16.0     202.0     973.2       0.0     0.021
     17.0     212.7    1180.7       0.0     0.023
     17.7     220.1    1332.9       0.0     0.025
     18.0     223.2    1398.1    0.0002     0.026
     19.0     234.1    1626.9     0.261     0.029
     20.0     245.7    1867.7      3.94     0.032
     21.0     270.0    2125.0      22.0     0.036
     22.0     300.0    2410.0      77.5     0.042
 END FTABLE290

 FTABLE    295                stream from DL & DHL to LSL
ROWS COLS ***
  11    4
    DEPTH      AREA    VOLUME     DISCH   ***
     (FT)   (ACRES)   (AC-FT)     (CFS)   ***
     0.00       0.0       0.0       0.0
     0.17       0.9       0.1       0.0
     0.33       0.9       0.3       0.0
     0.50       0.9       0.4       0.0
     0.67       0.9       0.6       0.0
     0.83       0.9       0.7       0.5
     1.00       0.9       0.9       1.0
     1.33       0.9       1.2       5.0
     1.67       1.0       1.5      10.0
     2.00       1.0       1.8      20.0
     3.00       5.0       10.       80.0
 END FTABLE295

 FTABLE    310                 Duck Lake
ROWS COLS ***                  STCOR = 1601.1
  15    5
    DEPTH      AREA    VOLUME      FLOW   SEEPAGE ***
     (ft)      (ac)   (ac-ft)     (cfs)     (cfs) ***
      0.0       0.0       0.0       0.0       0.0
      2.0       1.0       0.4       0.0     0.000
      3.0       3.4       2.6       0.0     0.000
      4.0       6.9       7.5       0.0     0.000
      5.0      12.2      16.9       0.0     0.000
      6.0      14.8      30.2       0.0     0.000
      7.0      17.6      46.7       0.0     0.000
      8.0      20.4      65.3       0.0     0.000
      9.0      23.6      87.5       0.0     0.000
      9.7      24.3     104.2       0.0     0.000
     10.0      24.6     111.4    0.0002     0.000
     11.0      32.0     139.0      0.15      0.00
     12.0      40.0     175.0       2.1      0.00
     13.0      50.0     220.0      11.2      0.00
     14.0      60.0     275.0      37.7      0.00
 END FTABLE310

 FTABLE    320                 Deep Hole Lake
ROWS COLS ***                  STCOR = 1594.8
  15    5
    DEPTH      AREA    VOLUME      FLOW   SEEPAGE ***
     (ft)      (ac)   (ac-ft)     (cfs)     (cfs) ***
      0.0       0.0       0.0       0.0       0.0
      1.0      24.5       0.3       0.0     0.003
      2.0      31.2      27.6       0.0     0.008
      3.0      39.1      63.3       0.0     0.014
      4.0      47.7     105.9       0.0     0.023
```

```
       5.0      57.4     159.3       0.0     0.035
       6.0      67.8     220.8       0.0      0.05
       7.0      82.3     297.3       0.0      0.07
       8.0      88.1     381.1       0.0      0.09
       9.0      93.3     470.4       0.0      0.10
      10.0      98.8     568.1       0.0     0.120
      11.0     119.5     671.6     0.084      0.16
      12.0     128.9     800.0       4.5      0.19
      13.0     140.0     940.0      46.8      0.22
      14.0     150.0    1100.0     245.6      0.25
  END FTABLE320

  FTABLE    330                 Skunk Lake
 ROWS COLS ***                  STCOR = 1594.1
    8    5
     DEPTH      AREA    VOLUME      FLOW   SEEPAGE ***
      (ft)      (ac)   (ac-ft)     (cfs)     (cfs) ***
       0.0       0.0       0.0       0.0       0.0
       1.0       0.5      0.22       0.0     0.000
       2.0       1.3      1.07       0.0     0.000
       3.0       4.3      4.00       0.0     0.002
       4.0       7.3      9.66       0.0     0.005
       5.0      12.0      19.0       0.5     0.010
       6.0      20.0      35.0       1.0     0.02
       7.0      30.0      60.0       3.0     0.04
  END FTABLE330

END FTABLES

END RUN
```